

LADDER OPERATION AND SPRING CHINOOK SALMON BROODSTOCK COLLECTION AT DWORSHAK NATIONAL FISH HATCHERY

A Review of Historical Operations and Influence on Program Performance

Dworshak Fisheries Complex

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EXECUTIVE SUMMARY

Information is presented to address concerns by fishery managers about the potential negative effects of the current ladder operation and broodstock collection strategy on the spring Chinook salmon stock at Dworshak NFH. The program is intended solely to provide sport and Tribal harvest. The program is not designed or intended to conserve or preserve the unique genetic or phenotypic characteristics of the current stock. In fact, the current stock was derived from multiple sources and is currently a genetic amalgamation of all the various segments comprising the entire Clearwater River spring Chinook salmon population.

The strategy used for operating the ladder and collecting broodstock is based on ensuring that adequate broodstock is collected while maximizing program efficiency and economy. Historically, when adult returns were lower, the ladder was opened earlier in the season and operated continuously. In more recent years when adult returns have been higher, the ladder has been opened later and operated intermittently. Managers have expressed concern that not collecting broodstock during the earlier part of the season could result in not meeting broodstock needs. A review of the historical operation of the ladder shows that the only years when broodstock needs have not been met have been in years when adult returns were not sufficient to meet those needs. Since 1998, broodstock needs have been met every year, except for 2005. Also, Dworshak NFH has been successful in collecting additional broodstock for other Clearwater River programs in recent years with plans to continue that effort.

Managers have also expressed concern that delayed ladder operation and not collecting broodstock over the entire spectrum of the natural run timing of the stock could lead to significant changes in run timing, genetics and other population characteristics. Available data

do not support the expressed concern. PIT tag data collected from adults returning to Bonneville, McNary, Ice Harbor, and Lower Granite dams from 2007 to 2014 showed no statistically significant differences in run timing between any of the Clearwater River stocks, including the Rapid River SFH stock, at any dam for any of the years included in the analysis.

Beginning in 2008, Chinook salmon broodstock at Dworshak NFH have been included in a basin-wide assessment for parentage based tracking (PBT) as a means to use genetics to identify hatchery stocks and groups of interest in returning salmon. These data demonstrate only a weak association between the mean spawn dates for 2-Ocean returning adult salmon used as broodstock at Dworshak NFH in 2012 and the spawn dates for their parents in 2008. While only a single year of information is available, these data suggest a significant overlap in progeny spawn dates between early and late spawning adults.

A consistent strategy of an early opening of the ladder to collect broodstock presents several management issues. First, early broodstock collection requires holding adults longer prior to spawning which increases the cost of chemical treatment and increases holding mortality, requiring collection of additional broodstock. Collection of additional broodstock reduces the numbers available for harvest. Also, early collection of broodstock removes the newer, fresher fish out of the harvestable population.

Finally, Dworshak NFH schedules major maintenance tasks during the period from April 15 to July 1 when annual production cycles, and water requirements are at their lowest level. This annual window is used to perform maintenance on the main pump house, intake, main aeration chamber, and the holding ponds. Since much of this maintenance is performed by contractors, sufficient lead time and work windows are required to adequately plan and perform the necessary work elements. Tighter schedules put the contractors at risk of default and bid prices increase as contractors assume greater risk on these projects.

In conclusion, the available data do not support the managers expressed concerns about the potential impacts of current ladder operation and broodstock collection strategy on the population biology of the spring Chinook stock at Dworshak NFH. Further, there are very practical and sound reasons for the current strategy from an economical, program efficiency, and infra-structural maintenance perspective.

Introduction

For the past several years, concern has been expressed by Idaho Department of Fish and Game and Nez Perce Tribal fishery managers regarding the strategy used by Dworshak National Fish Hatchery for operating the ladder to collect spring Chinook salmon broodstock. This paper provides information on the purpose of the program, reviews historical ladder operations, presents information and data on operational performance relative to the concerns that have been expressed, discusses some implications of ladder operations to production efficiency, and lists some limitations to operations due to maintenance and infra-structure constraints.

The strategy used by Dworshak NFH for operating the ladder and broodstock collection is based on minimizing handling stress for the salmon population while accommodating requests from fisheries managers. In all cases, assuring broodstock collection is the first priority for the program. As such, when runs have been low and the potential for collecting adequate broodstock has been in question, the ladder has been opened early and operated continuously. When runs have been larger, the strategy has been to open the ladder later, and only for periods long enough to collect adults needed for spawning. This strategy has two distinct advantages. First, it keeps the earlier returning adults in the river longer, allowing fresher fish that are in better condition to be harvested. Second, it reduces the time that broodstock are held on station prior to spawning. This approach results in lower cost for treatment with formalin to control fungal infections and lower overall adult holding mortality prior to spawning.

Purpose and Brood Stock History of the Spring Chinook Salmon Program

The spring Chinook salmon production program at the Dworshak Fisheries Complex is part of the Lower Snake River Compensation Plan (LSRCP) and is designed as an isolated harvest program intended to provide sport and Tribal harvest and broodstock for continuing the program (U.S. Fish and Wildlife Service 2013). This program is not intended for conservation or restoration of the extirpated wild populations in the Clearwater River. The broodstock at Dworshak NFH was created by incorporating adults from a variety of hatchery stocks over the years and does not represent a distinct population segment of spring Chinook salmon.

Table 1 lists the broodstock history for the Dworshak NFH program since 1983. The program was initially started using spring Chinook salmon stock from the Leavenworth and Little White Salmon NFH programs. Eggs were transferred from these facilities to Dworshak NFH and provided the smolt releases from 1983 to 1986. Since these stocks were very strongly influenced by transfers from Carson NFH to Leavenworth and Little White Salmon NFHs, the early Dworshak spring Chinook salmon stock was considered a Lower Columbia River derivative. The spring Chinook salmon program for brood years 1985 and 1986 consisted entirely of eggs transferred from Rapid River State Fish Hatchery (SFH). Rapid River SFH used spring Chinook salmon trapped at Hells Canyon Dam (considered an upper Snake River stock) as an original parent stock. Smolts released from Dworshak NFH in 1987 and 1988 were entirely Rapid River stock, shifting the program away from using the Lower Columbia River sources.

In the 23 years since 1988, Dworshak NFH has maintained its program from returns to its own rack, with the exception of two years when the program was below full production. In 1995, releases from Dworshak NFH were one third Kooskia NFH spring Chinook salmon stock (also a Lower Columbia River derivative). In 2001, about one third of the Dworshak release was Rapid River stock (Lookingglass Fish Hatchery adults collected at Lower Granite Dam). The returns to Dworshak NFH from 1989 to 2001 were referred to as Dworshak stock, since they were progeny of returns to Dworshak NFH, rather than direct products from transfers of Rapid River stock. Since 2001, with continual increasing success of other State and Tribal spring Chinook salmon production programs, and recognition by all the Co-Managers that the returns of spring Chinook salmon to the Clearwater River have become closely integrated by mutually supported efforts at backfilling broodstock needs during low return years, we now refer to Dworshak NFH returns simply as Clearwater River stock. In addition, measurable numbers of adult salmon from other Clearwater River programs have been incorporated into the broodstock at Dworshak NFH. Coded-wire tag recovery data show that the percentages of Dworshak NFH origin adults in the brood stock for 2011, 2012, 2013, and 2014 were 85%, 73%, and 50%, and 88%, respectively.

In summary, the stock of spring Chinook salmon used at Dworshak NFH was derived from multiple sources and is currently an amalgamation of the combined production programs in the Clearwater Basin that incorporates the genetic variability of the entire Clearwater River adult return. As such, maintaining or conserving phenotypic or genotypic integrity of the stock is not the highest program priority and need only be considered when the program goal and objectives may be significantly compromised.

Table 1. Brood stock history of Dworshak NFH spring Chinook salmon smolts directly released from the hatchery, 1983-2015. (RR = Rapid River, KK = Kooskia, DW = Dworshak, LE = Leavenworth, LW = Little White Salmon, CW = Clearwater River).

Release Year	Brood Stock Composition
1983	75% LW, 12% RR, 13% LE
1984	100% LE
1985	68% LW, 32% LE
1986	100% LE
1987 – 1988	100% RR
1989 – 1994	100% DW
1995	66% DW, 34% KK
1996 – 2000	100% DW
2001	64% DW, 36% RR
2002-2015	100% CW

Historical Review of Ladder Operations

Adult Chinook salmon generally begin arriving at Lower Granite Dam about the middle of April, peaking about the middle of May (**Figure 1**). Adults continue passing over Lower Granite Dam until the last of September, but fish crossing Lower Granite after June 17 are considered summer Chinook. Arrival time of spring Chinook salmon into the North Fork Clearwater River usually occurs several weeks after crossing over Lower Granite Dam.

Operations from 1987 to 1998

During 1987 to 1998, Chinook salmon runs were generally low and the ladder was typically opened in mid- to late May and run continually for the duration of the trapping season to ensure collection of broodstock. From 1991 to 1998, we did not collect sufficient numbers to meet brood stock requirements (1,000 adults) except in 1997 (**Table 2**). Although some Tribal harvest occurred, no sport harvest seasons occurred until 1997 and 1998. These early years were plagued with low on-station performance resulting from high mortality due to Bacterial Kidney Disease.

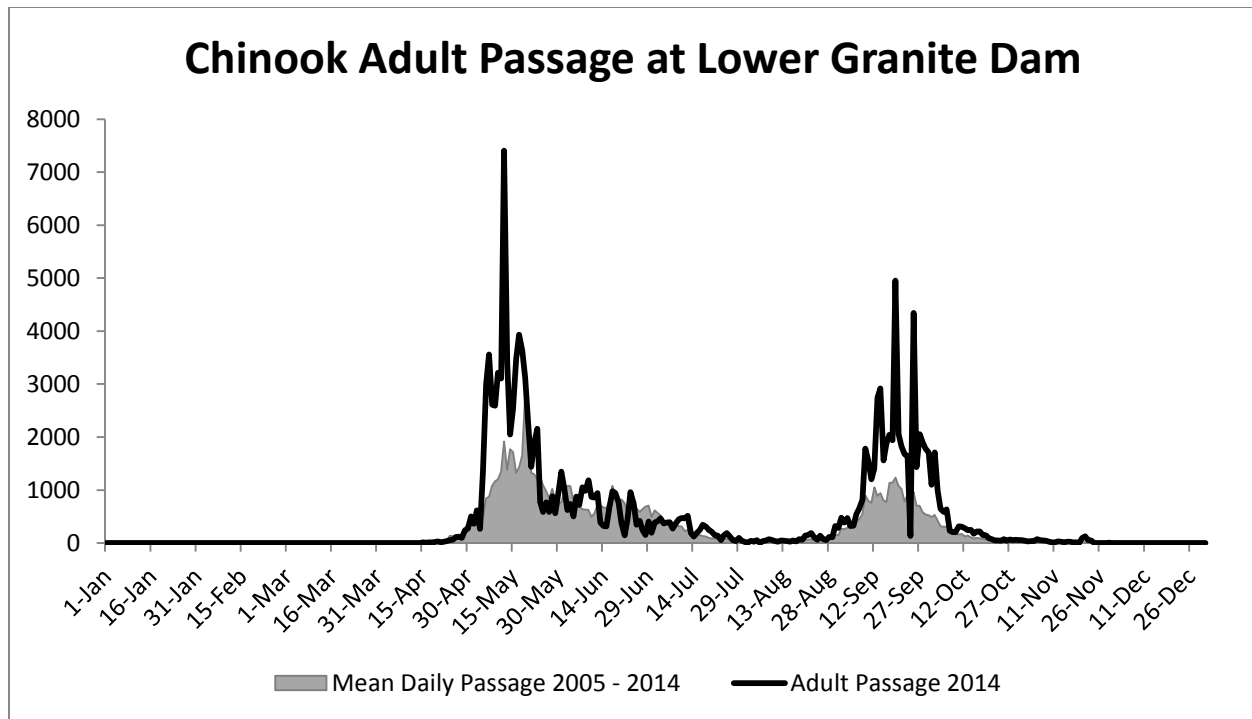


Figure 1. Historical arrival time of Chinook salmon at Lower Granite Dam.

Operations from 1999 to Present

By the end of the 1990's, mortality due to Bacterial Kidney Disease had been greatly reduced from the program as a result of aggressive culling of eggs from adult females that tested high for presence of *R. salmoninarum* and from injecting adult females with Erythromycin prior to spawning to reduce levels of this bacteria in adults in order to decrease the risk of vertical transmission to the progeny. Other program improvements together with changes in ocean conditions resulted in significant increases in adult returns from 2000 to the present with the exception of 2005. With the change in adult returns, we shifted our ladder openings later to June, operating the ladder intermittently. In 2011 and 2014, the trapping began successfully in July for the first times in operational history (**Table 2**). In recent years, we have also been able to collect additional brood stock for other Idaho Department of Fish and Game and Nez Perce Tribal production programs, assisting in the development of increasing the overall production of spring Chinook salmon in the Clearwater River basin.

Table 2. Date of ladder opening at Dworshak National Fish Hatchery to collect spring Chinook salmon brood stock, 1987-2014.

Run Year	First Date of Ladder Opening	Mode of Ladder Operation	Rack Return
1987	22-May	Continual	2,017
1988	17-May	Continual	1,972
1989	26-May	Continual	1,700
1990	18-May	Continual	2,042
1991	23-May	Continual	165
1992	22-May	Continual	370
1993	21-May	Continual	823
1994	25-May	Continual	74
1995	19-May	Continual	195
1996	24-May	Continual	963
1997	19-May	Continual	3,150
1998	21-May	Continual	915
1999	4-Jun	Continual	800
2000	15-Jun	Intermittent	3,202
2001	12-Jun	Intermittent	4,018
2002	3-Jun	Intermittent	2,157
2003	28-May	Intermittent	3,422
2004	27-May	Intermittent	2,356
2005	18-May	Continual	882
2006	1-Jun	Continual	1,354
2007	5-Jun	Continual	2,110
2008	16-Jun	Intermittent	1,857
2009	10-Jun	Continual	2,171
2010	1-Jun	Continual	1,225
2011	5-Jul	Continual	1,075
2012	25-Jun	Continual	1,883
2013	17-Jun ¹	Continual ²	2,646
2014	1-July	Continual	2,806

¹ Opening was delayed due to scheduled maintenance.

² Ladder was not operated according to SOPs until August 9.

Operational Performance

In regard to the current operation of the ladder, concern has been expressed about the potential effects of delaying the ladder opening on collection of broodstock over the entire spectrum of the run. Such effects could be manifested by changes in run timing, genetics and other population characteristics. Another concern expressed has been the potential for failing to collect sufficient broodstock when collections are delayed. The following information is presented to address these and other concerns regarding potential effects of ladder operations on the population and production program

Run Timing of Dworshak NFH and Other Clearwater River Stocks

Assuming that arrival time of Clearwater River spring Chinook salmon is at least partly genetically determined, then operating the ladder later in the season may reduce the component of early-returning adults in the population. If so, we might expect to observe a trend over time of delayed passage at mainstem Columbia and Snake River dams. We might also expect that this effect would contrast with the arrival timing for other stocks that are managed differently in the region.

Bonneville Dam

Daily counts at the dam from 1987 to 1994 show adults Chinook salmon starting to arrive the first two weeks in April with Jacks arriving about two weeks later. With the implementation of adult PIT-tag detection equipment, the ability to distinguish individual stocks at Bonneville Dam became available. In 1996, Dworshak NFH was included in the Comparative Survival Study allowing a large sample of PIT-tagged fish (50,000+ smolts per year) to determine adult run timing at Bonneville Dam. By 2007, there were sufficient stocks being PIT-tagged in large numbers in the Clearwater River to allow for comparison of the run timing between individual stocks. **Table 3** lists the median arrival date at Bonneville Dam for Dworshak NFH spring Chinook salmon as well as Clearwater State Fish Hatchery, Kooskia NFH, and Nez Perce Tribal Hatchery. While not a Clearwater River stock, Rapid River State Fish hatchery is also included, as it is the source of the Dworshak NFH stock. The median arrival date at Bonneville Dam ranges from April 26 to May 13 for all stocks, with no more than 8 days separating the earliest arriving stock from the latest in any given year. There were no statistically significant differences in mean median arrival date at Bonneville Dam between any of the five stocks as determined by one-way ANOVA ($F(4,32) = 0.387$, $p = .816$). Cumulative run timing for all five stocks at Bonneville Dam are given in **Figures 2 – 9**.

Table 3. Median arrival date of spring Chinook salmon at Bonneville Dam.

	2007	2008	2009	2010	2011	2012	2013	2014
DNFH	2-May	4-May	6-May	29-Apr	10-May	8-May	4-May	1-May
CFH	9-May	4-May	7-May	29-Apr	7-May	9-May	4-May	1-May
KNFH		8-May	13-May	26-Apr	12-May	8-May	2-May	30-Apr
NPTH			5-May	26-Apr	6-May	8-May	2-May	30-Apr
RRSFH	7-May	4-May	8-May	26-Apr	5-May	6-May	3-May	1-May

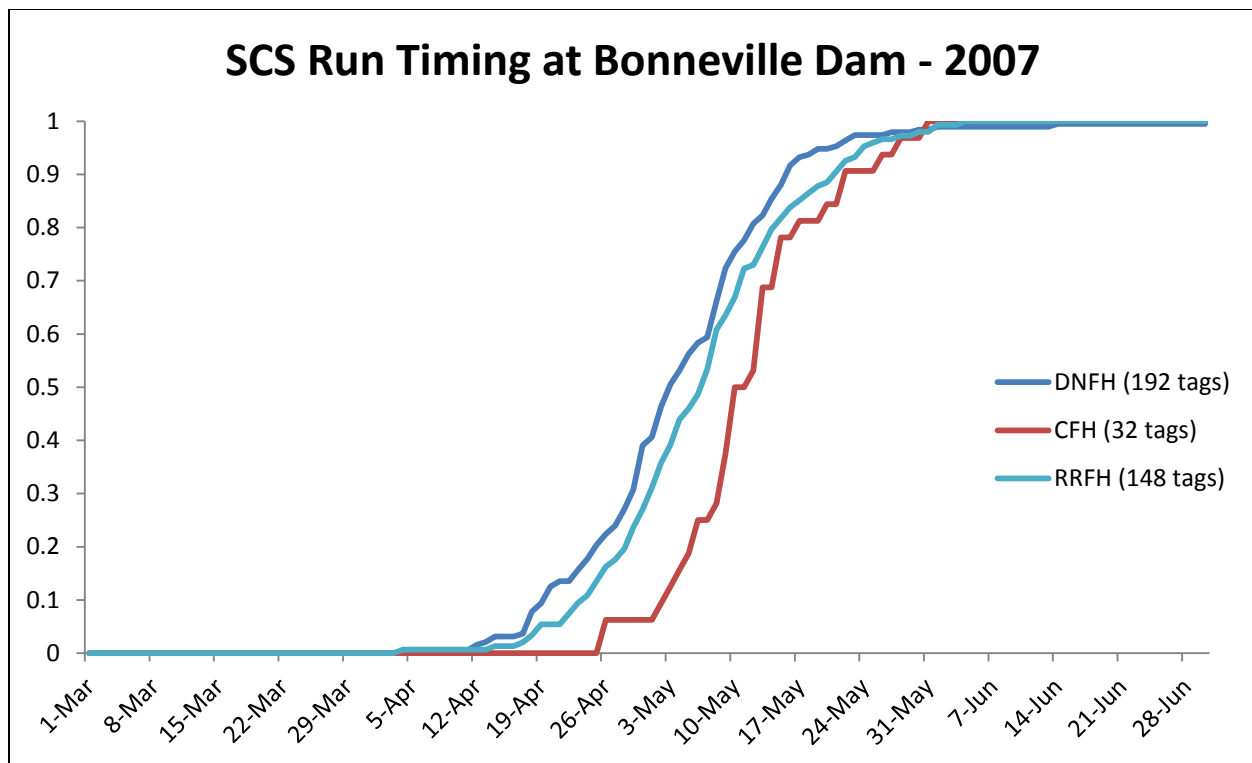


Figure 2. Spring Chinook salmon run timing at Bonneville Dam in 2007.

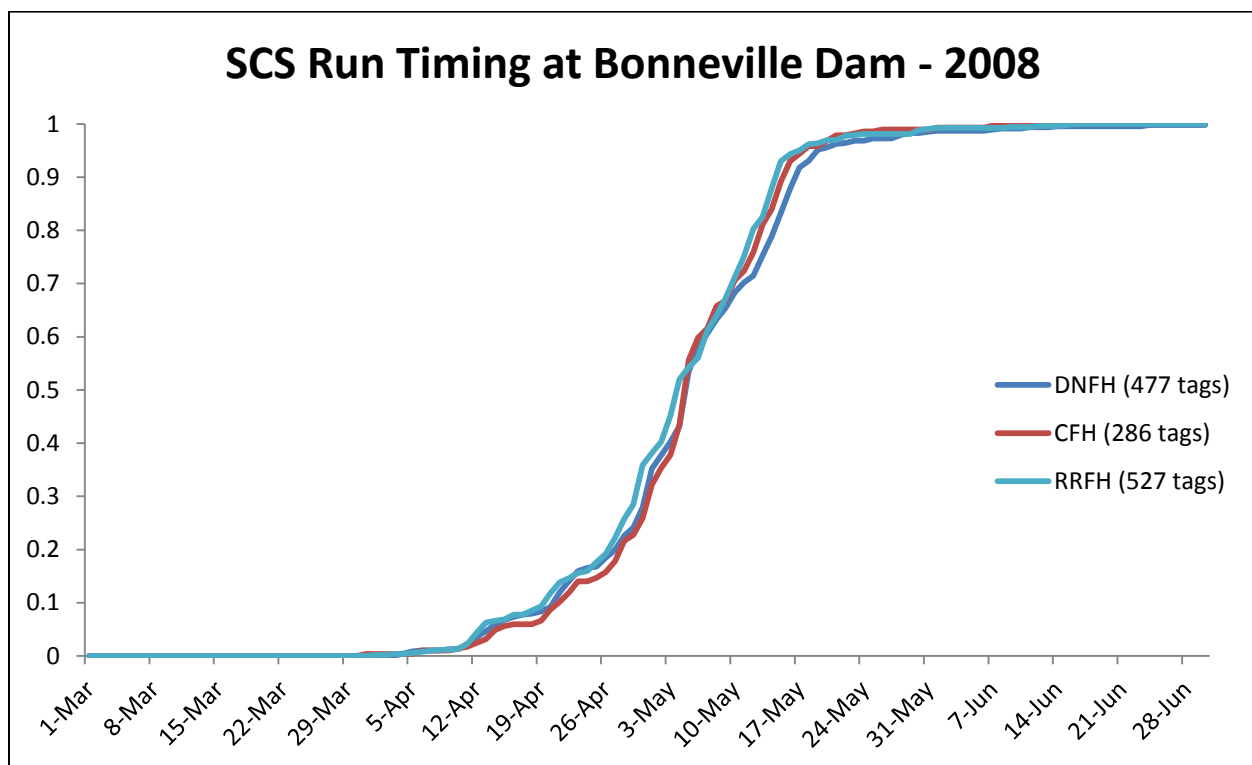


Figure 3. Spring Chinook salmon run timing at Bonneville Dam in 2008.

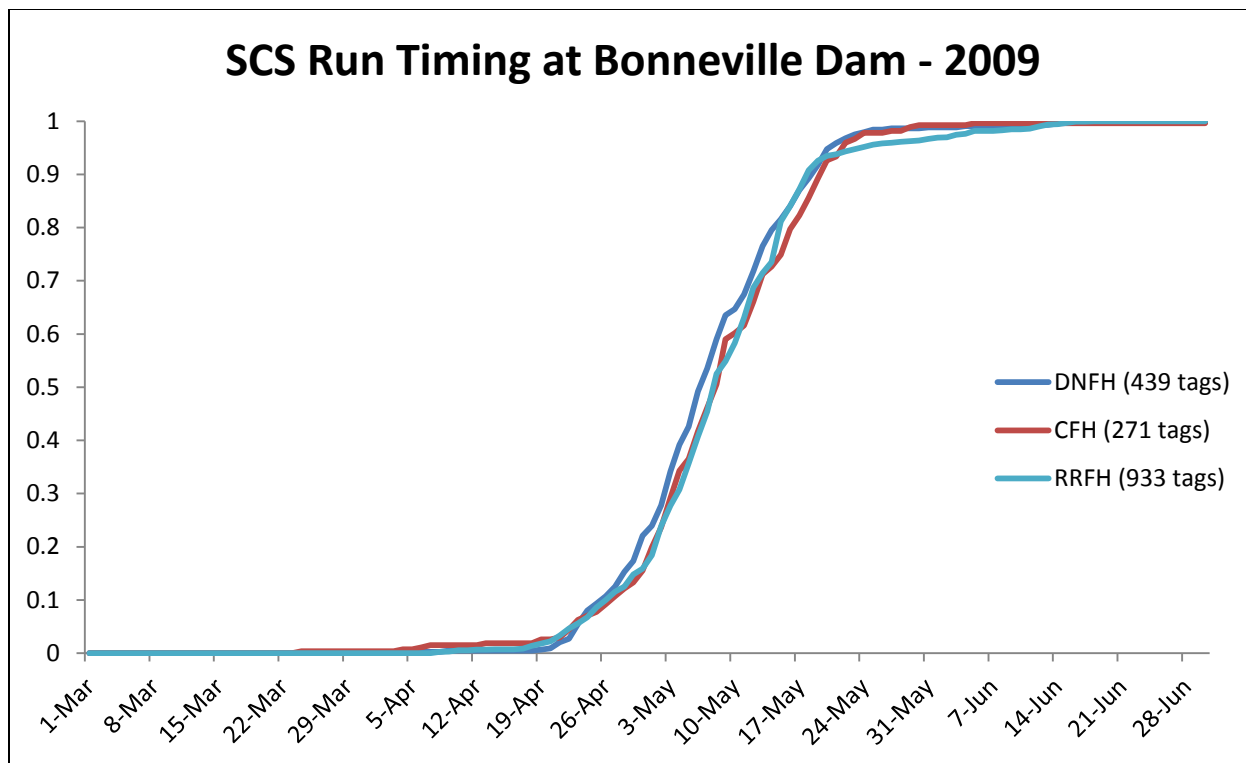


Figure 4. Spring Chinook salmon run timing at Bonneville Dam in 2009.

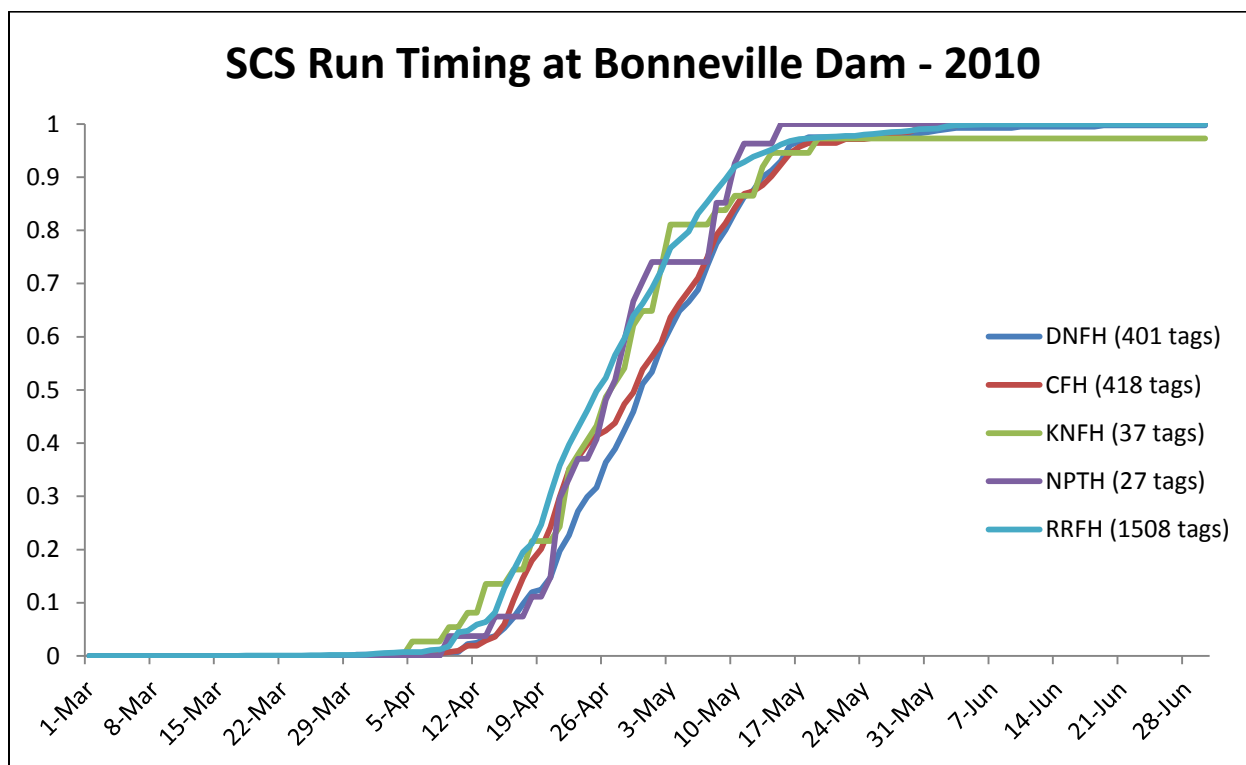


Figure 5. Spring Chinook salmon run timing at Bonneville Dam in 2010.

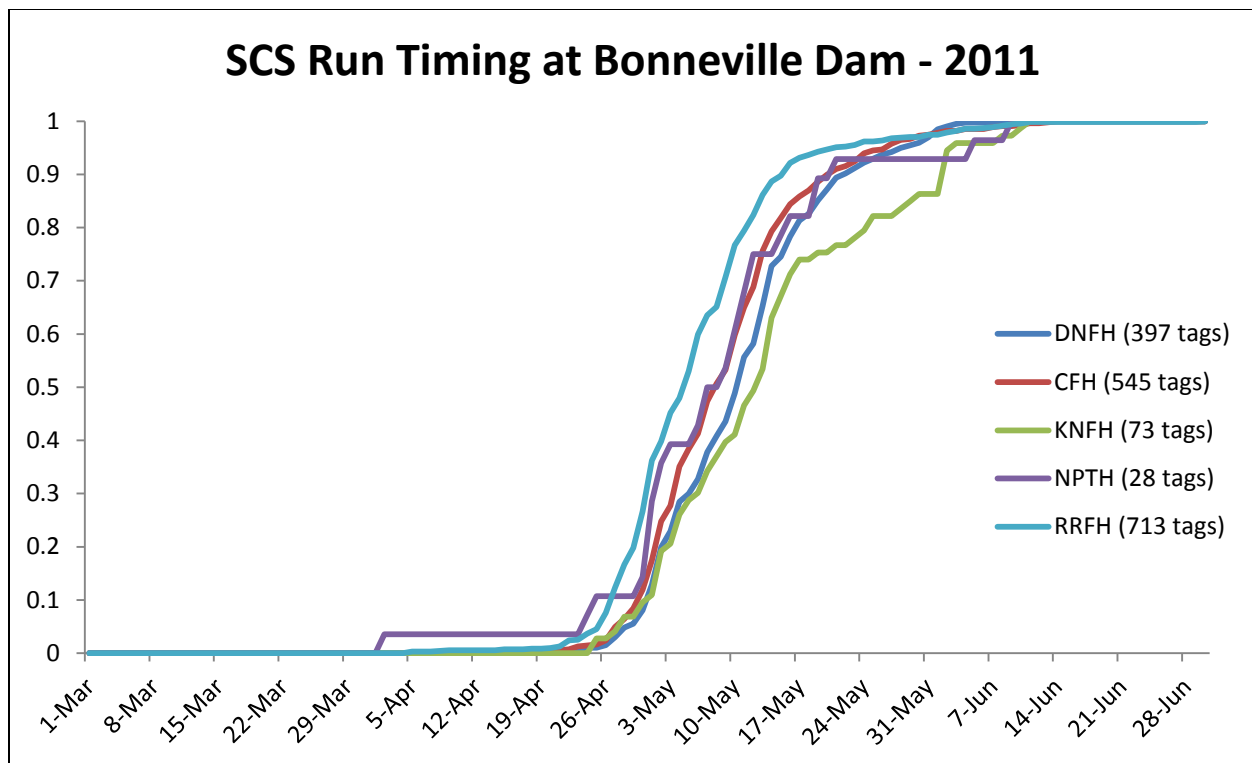


Figure 6. Spring Chinook salmon run timing at Bonneville Dam in 2011.

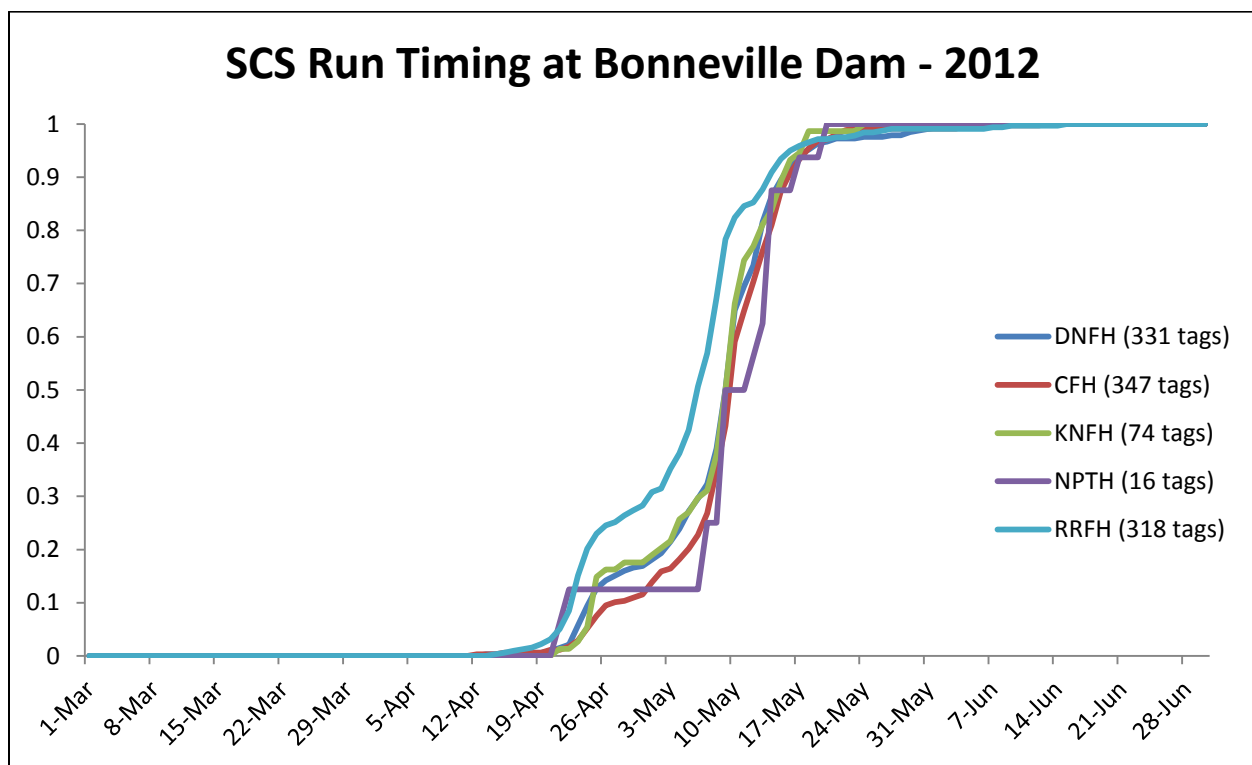


Figure 7. Spring Chinook salmon run timing at Bonneville Dam in 2012.

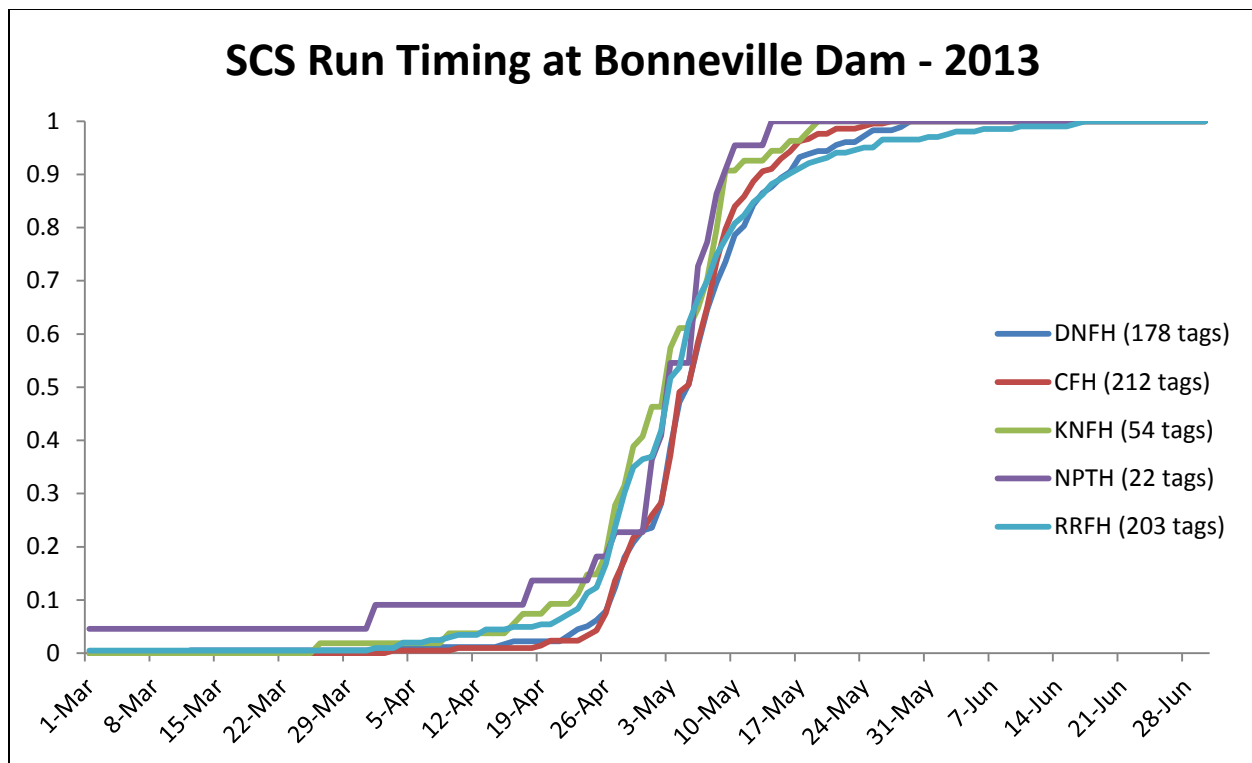


Figure 8. Spring Chinook salmon run timing at Bonneville Dam in 2013.

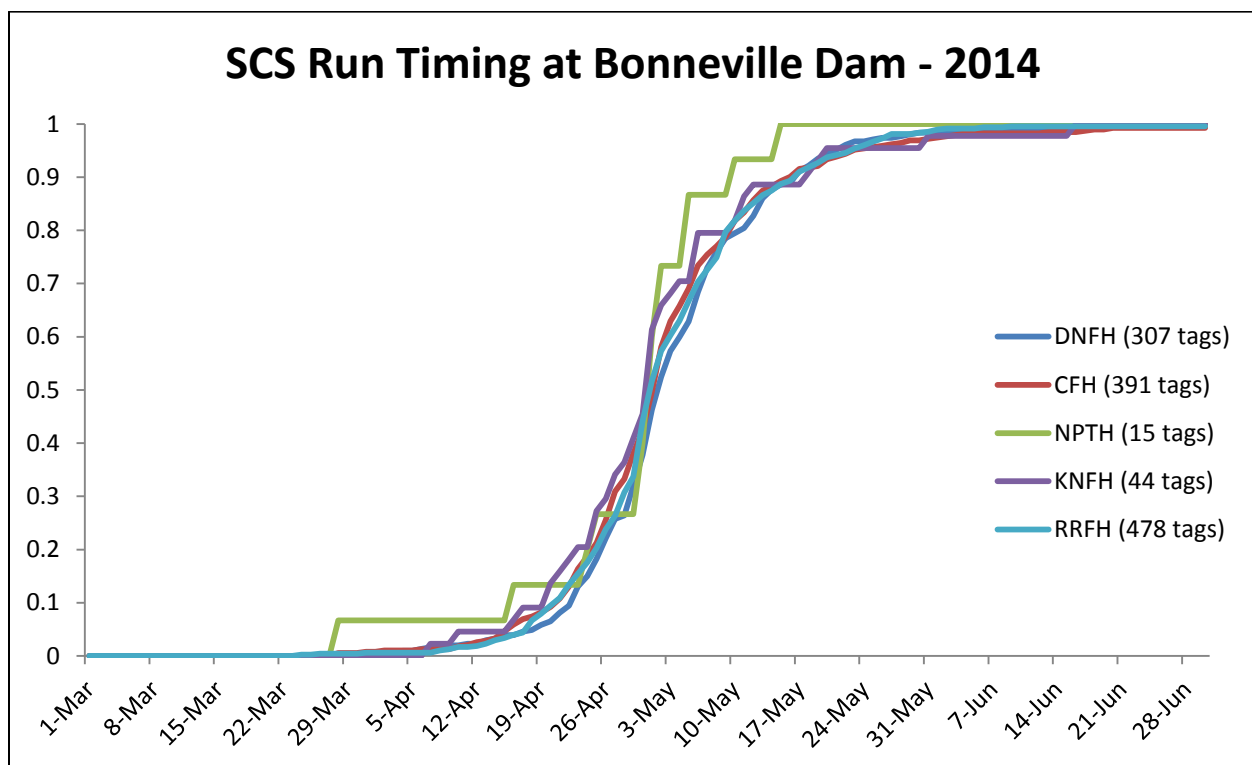


Figure 9. Spring Chinook salmon run timing at Bonneville Dam in 2014.

McNary Dam

Table 4 list the median arrival date at McNary Dam for Dworshak NFH spring Chinook salmon and other stocks. The median arrival date at McNary Dam ranges from May 1 to May 17 for all stocks, with no more than 8 days separating the earliest arriving stock from the latest in any given year. There were no statistically significant differences in mean median arrival date at McNary Dam from 2007 to 2014 between any of the five stocks as determined by one-way ANOVA ($F(4,31) = 0.186$, $p = .944$). Cumulative run timing for all five stocks at McNary Dam are given in **Figures 10 – 17**.

Table 4. Median arrival date of spring Chinook salmon at McNary Dam.

	2007	2008	2009	2010	2011	2012	2013	2014
DNFH	11-May	14-May	13-May	6-May	15-May	15-May	10-May	8-May
CFH	17-May	14-May	14-May	6-May	14-May	15-May	10-May	6-May
KNFH			11-May	2-May	19-May	15-May	8-May	6-May
NPTH			17-May	1-May	16-May	14-May	8-May	6-May
RRFH	13-May	14-May	15-May	4-May	11-May	14-May	9-May	8-May

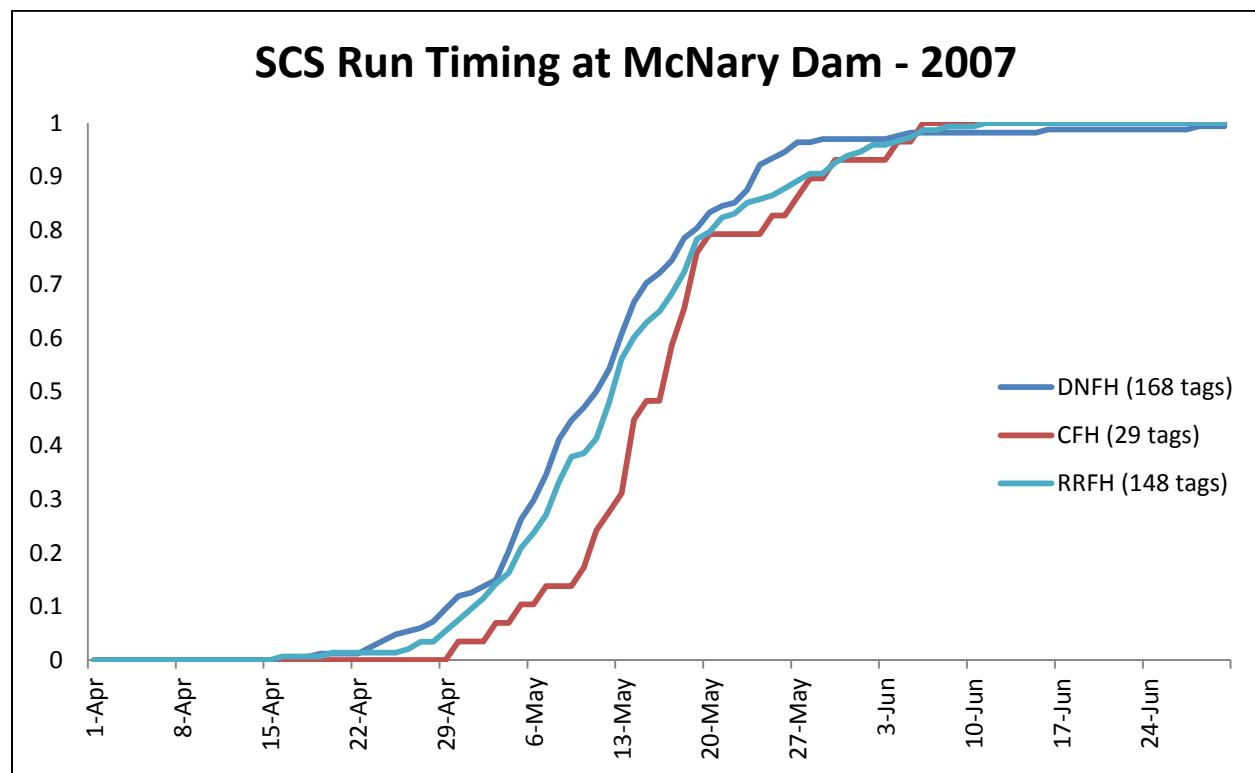


Figure 10. Spring Chinook salmon run timing at McNary Dam in 2007.

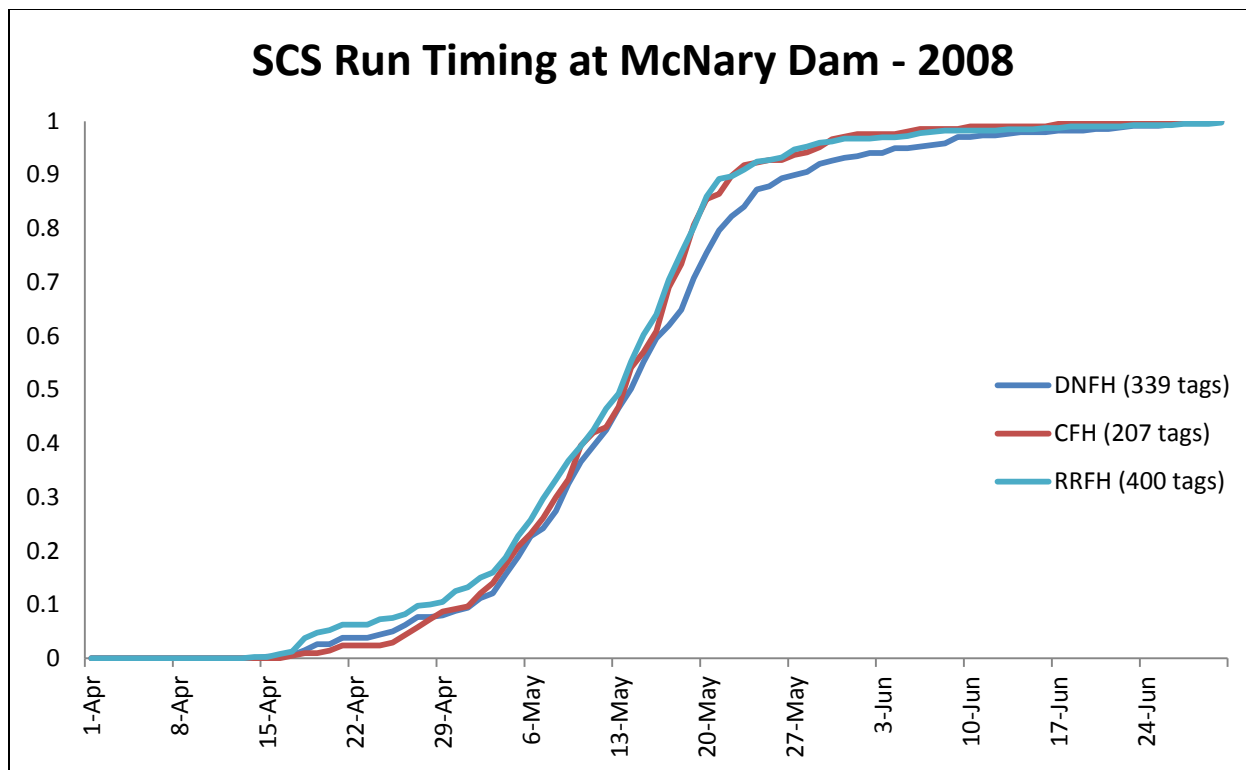


Figure 11. Spring Chinook salmon run timing at McNary Dam in 2008.

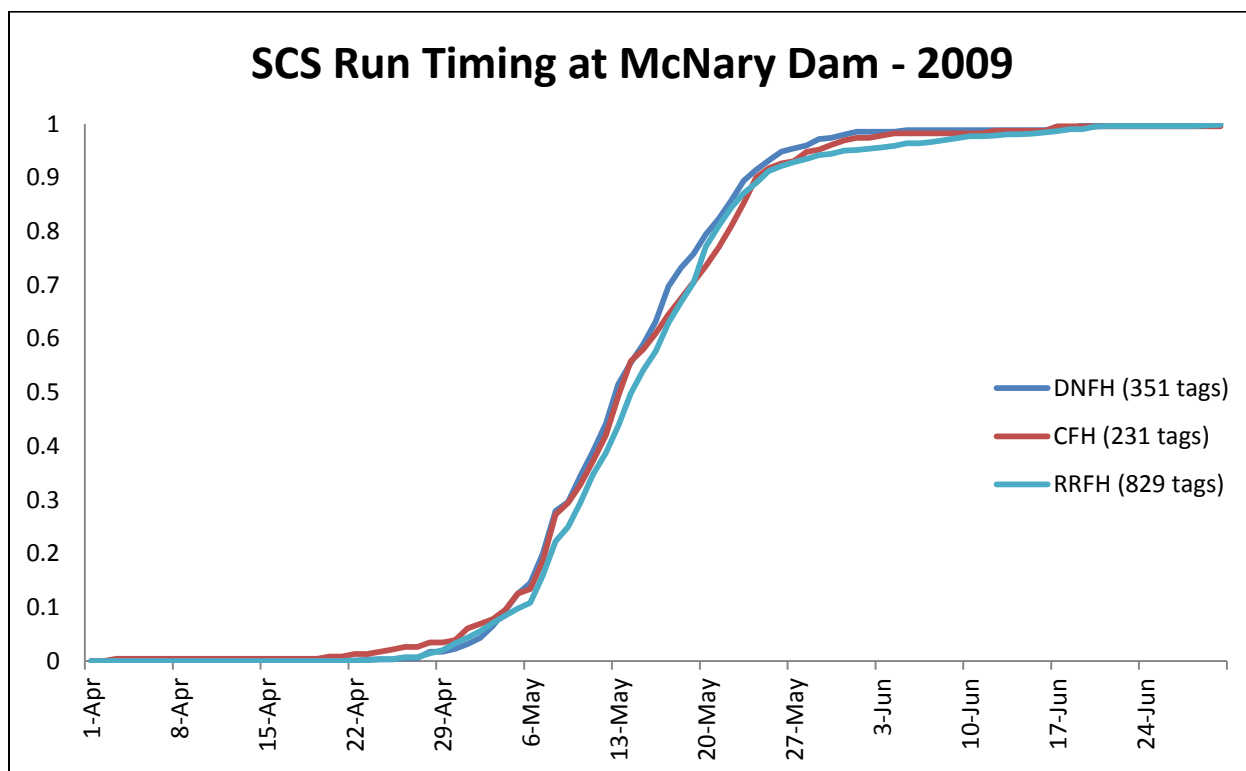


Figure 12. Spring Chinook salmon run timing at McNary Dam in 2009.

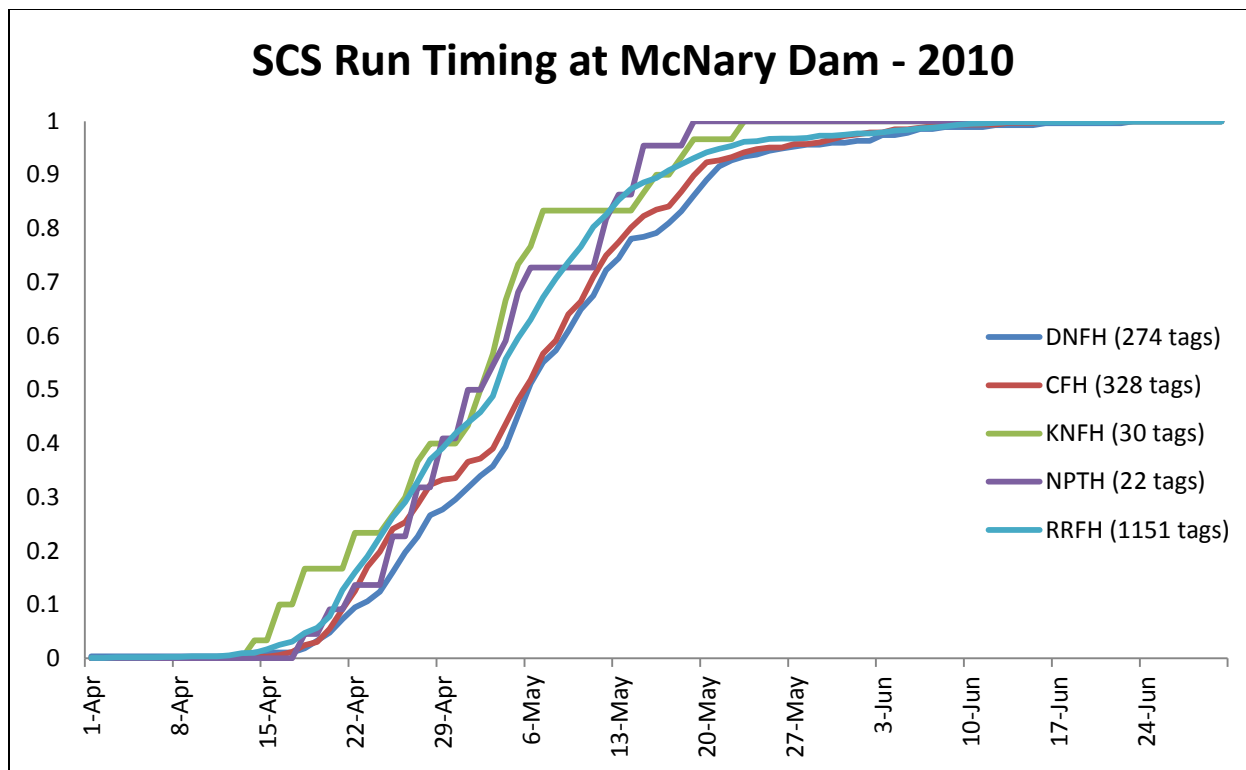


Figure 13. Spring Chinook salmon run timing at McNary Dam in 2010.

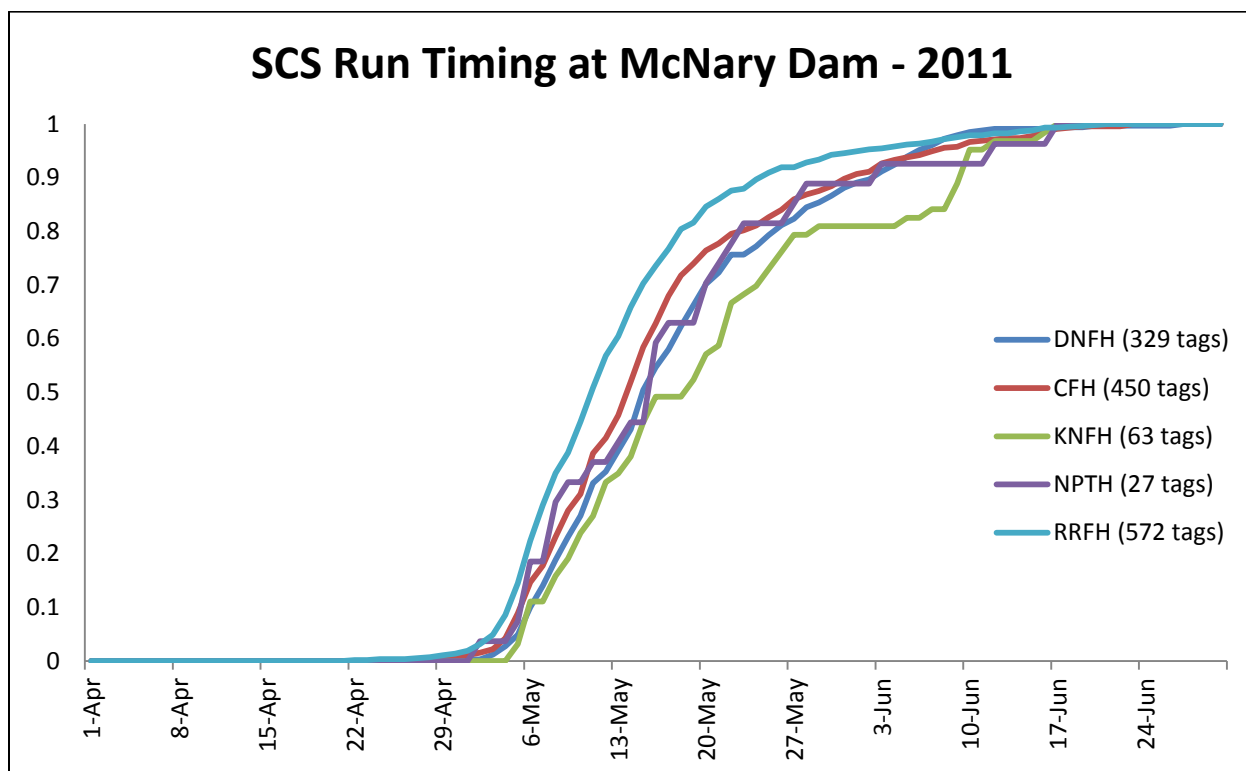


Figure 14. Spring Chinook salmon run timing at McNary Dam in 2011.

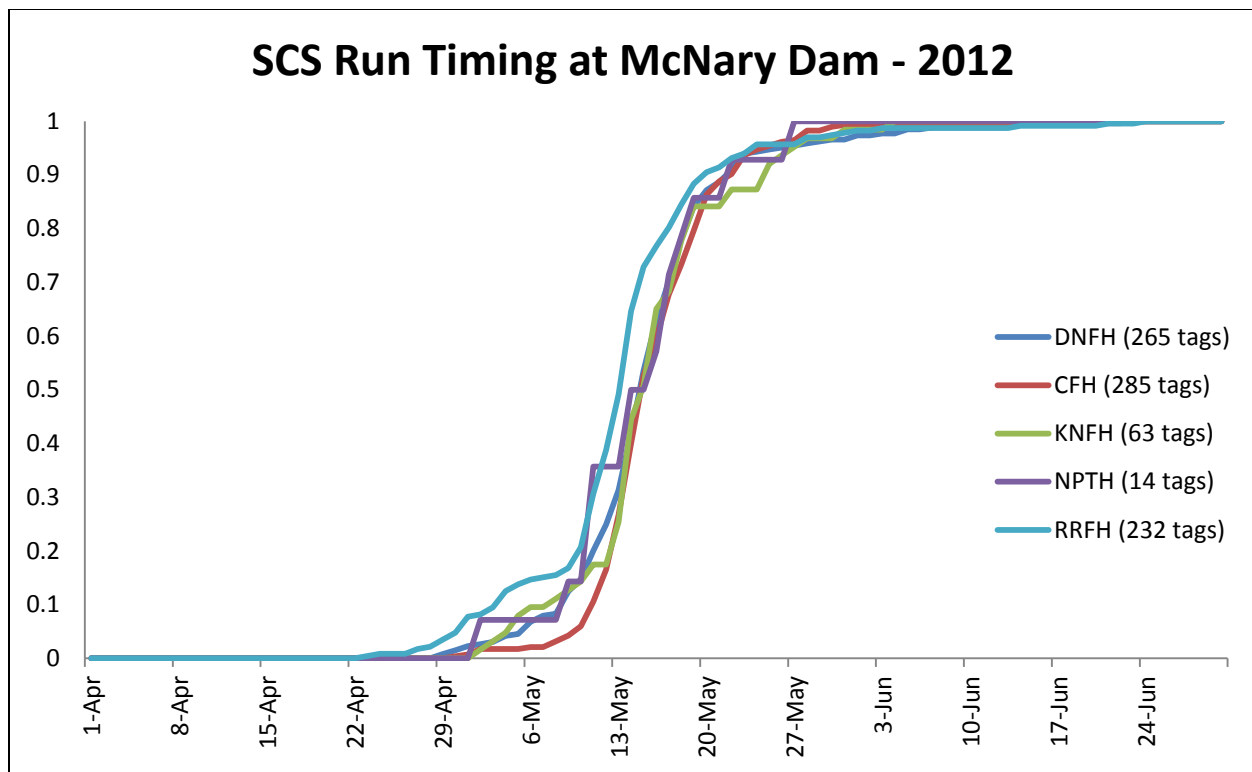


Figure 15. Spring Chinook salmon run timing at McNary Dam in 2012.

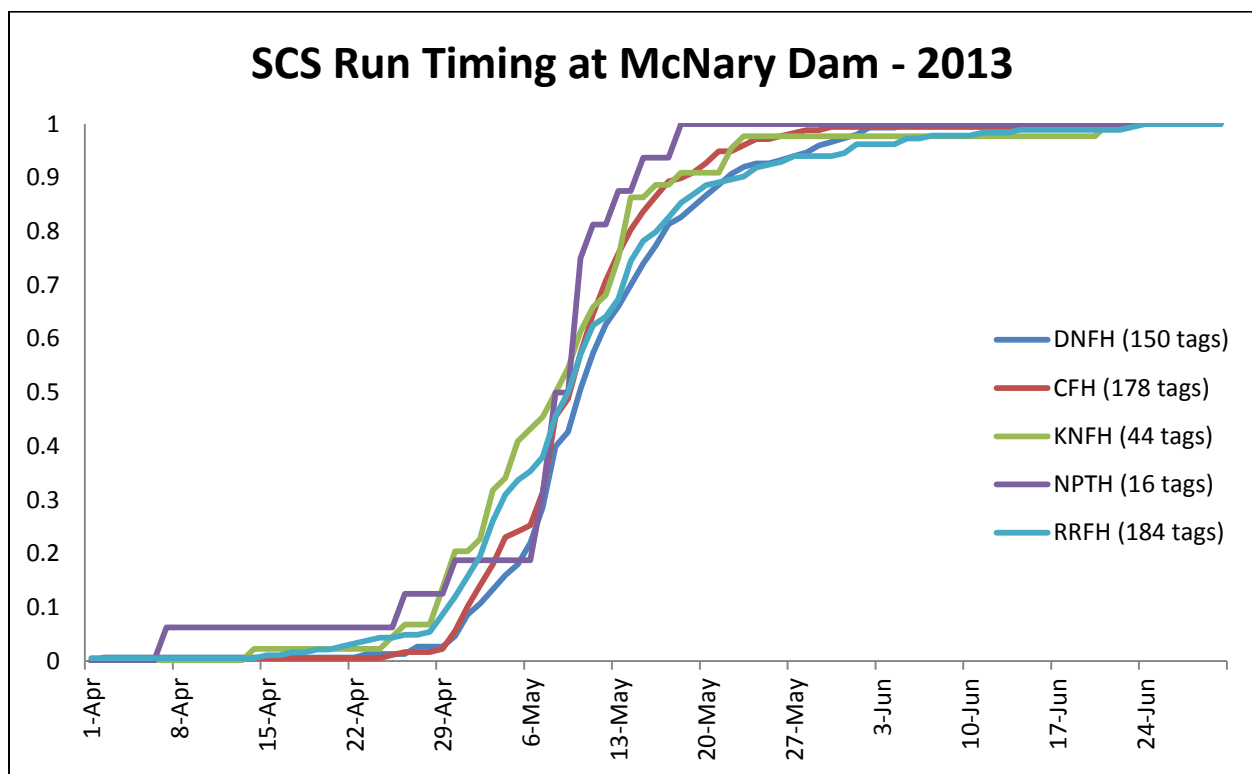


Figure 16. Spring Chinook salmon run timing at McNary Dam in 2013.

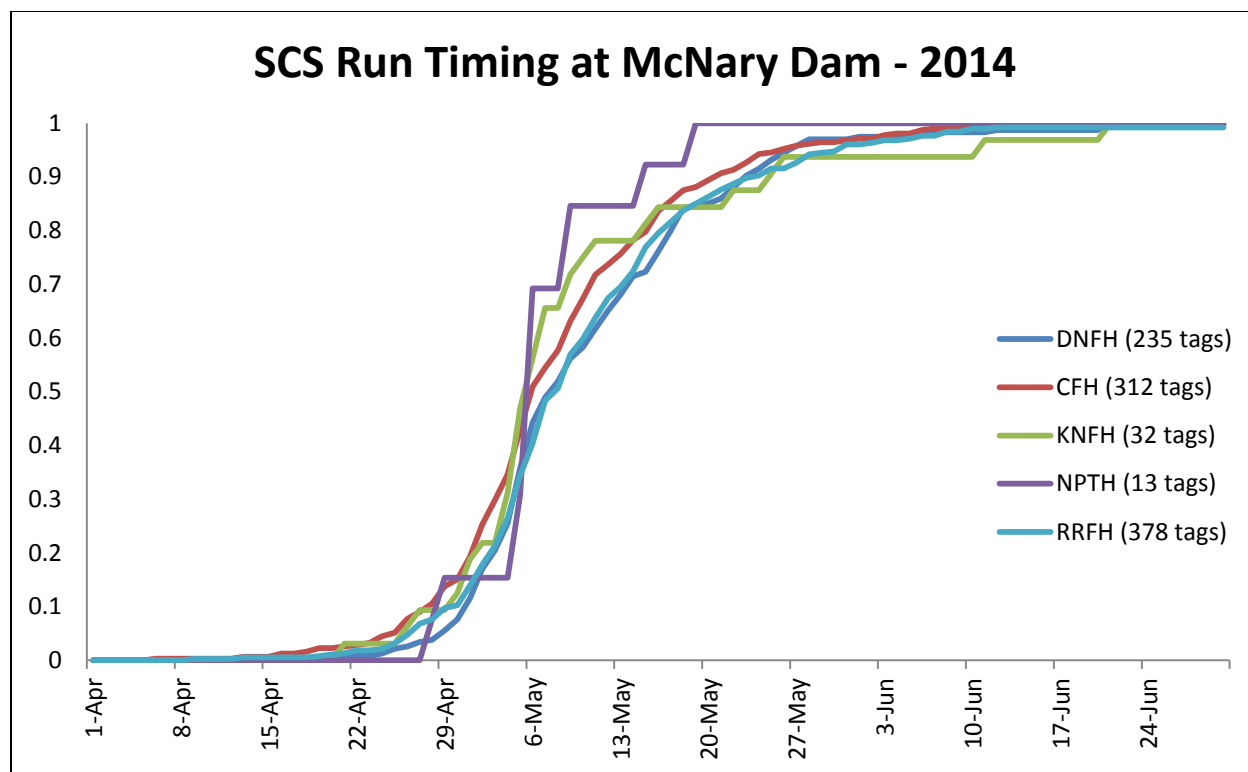


Figure 17. Spring Chinook salmon run timing at McNary Dam in 2014.

Ice Harbor Dam

Table 5 list the median arrival date at Ice Harbor Dam for Dworshak NFH spring Chinook salmon and other stocks. The median arrival date at Ice Harbor Dam ranges from April 30 to May 27 for Nez Perce Tribal hatchery spring Chinook salmon, and from May 3 to May 22 for all other stocks. In two years the Nez Perce Tribal hatchery stock differed greatly from the other Clearwater stocks – 2007, when they arrive 14 days earlier than any other stock, and 2010 when they arrived 18 days later. In other years, no more than nine days separated the earliest arriving stock from the latest. There were no statistically significant differences in mean median arrival date at Ice Harbor Dam from 2007 to 2014 between any of the five stocks as determined by one-way ANOVA ($F(4,30) = 0.538$, $p = .709$). Cumulative run timing for all five stocks at Ice Harbor Dam are given in **Figures 18 – 25**.

Table 5. Median arrival date of spring Chinook salmon at Ice Harbor Dam.

	2007	2008	2009	2010	2011	2012	2013	2014
DNFH	14-May	16-May	15-May	9-May	18-May	17-May	12-May	9-May
CFH	19-May	15-May	15-May	8-May	16-May	17-May	11-May	8-May
KNFH				3-May	22-May	17-May	9-May	8-May
NPTH	30-Apr	21-May	10-May	27-May	18-May	19-May	11-May	9-May
RRFH	14-May	15-May	16-May	5-May	13-May	15-May	11-May	9-May

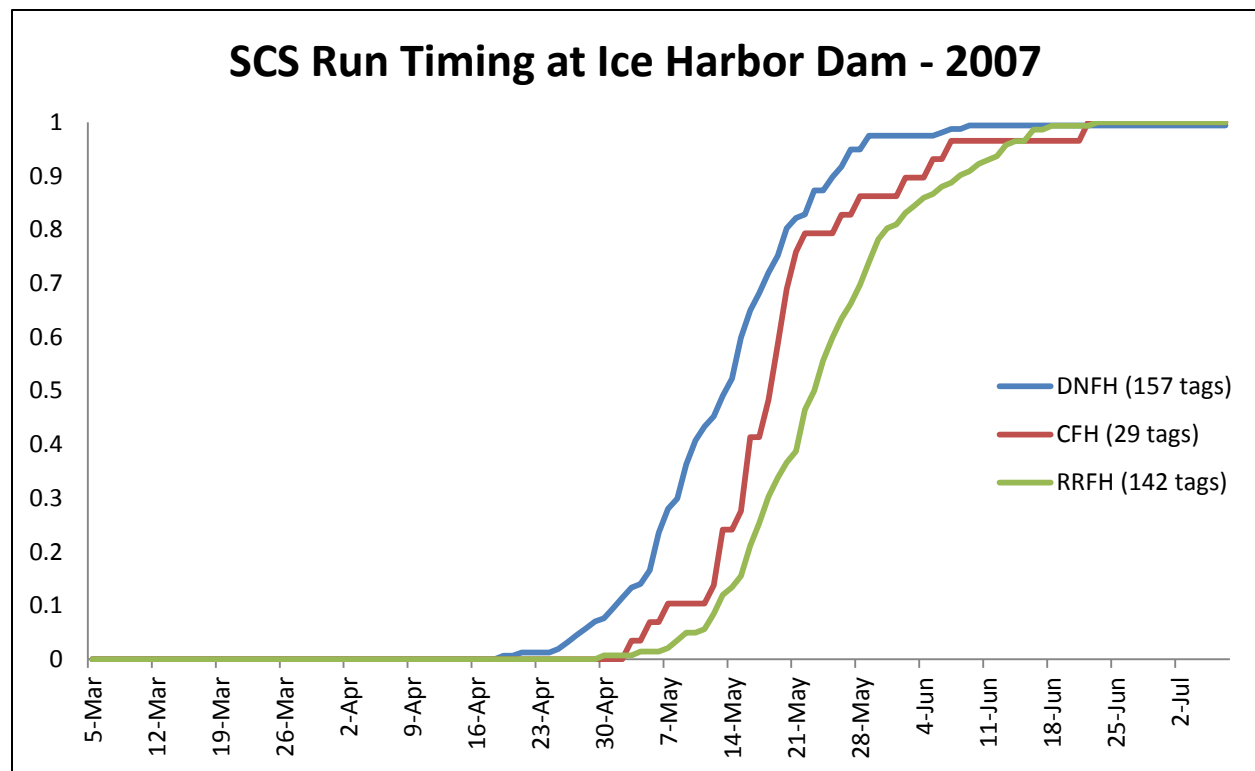


Figure 18. Spring Chinook salmon run timing at Ice Harbor Dam in 2007.

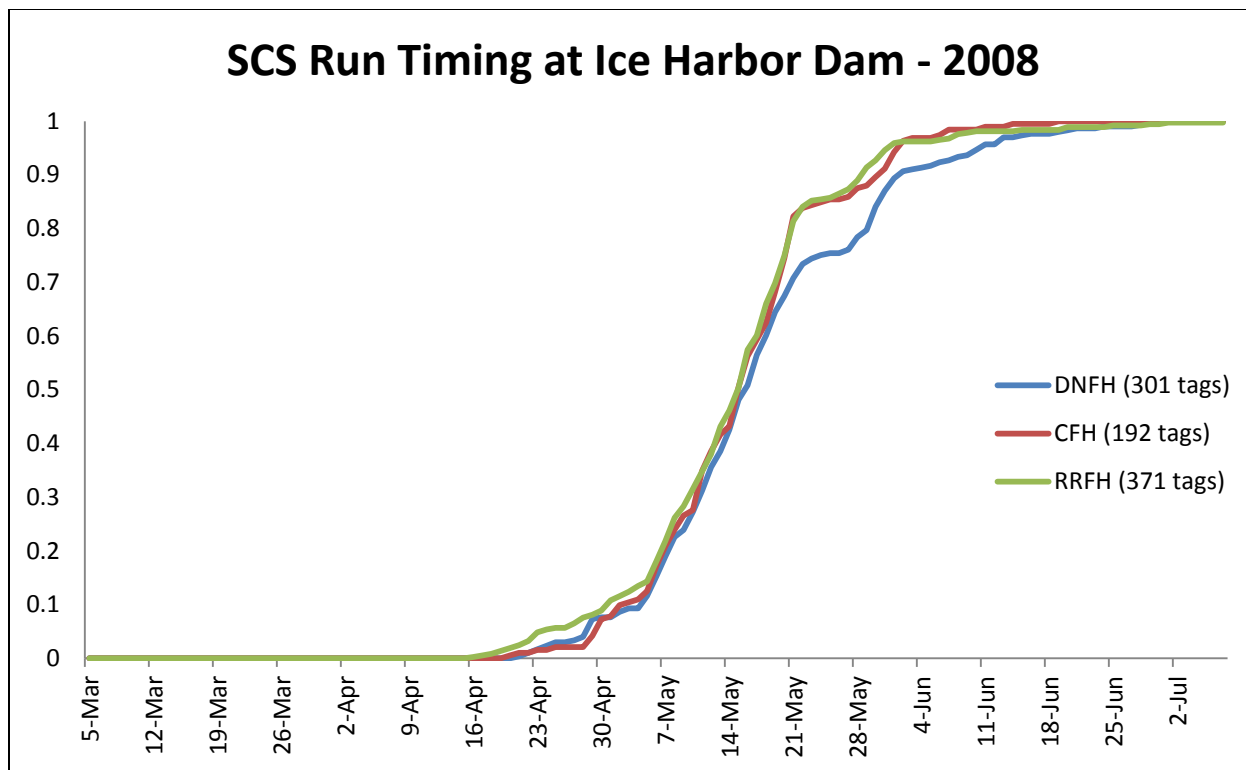


Figure 19. Spring Chinook salmon run timing at Ice Harbor Dam in 2008.

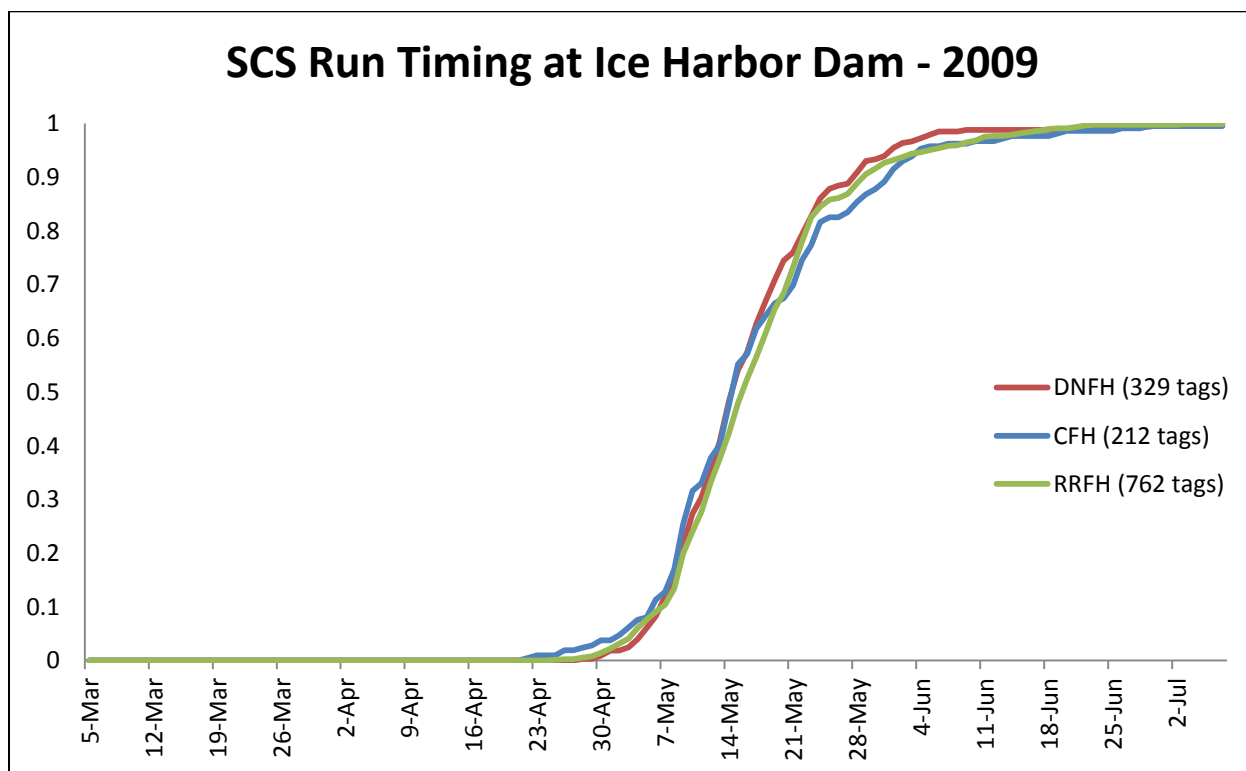


Figure 20. Spring Chinook salmon run timing at Ice Harbor Dam in 2009.

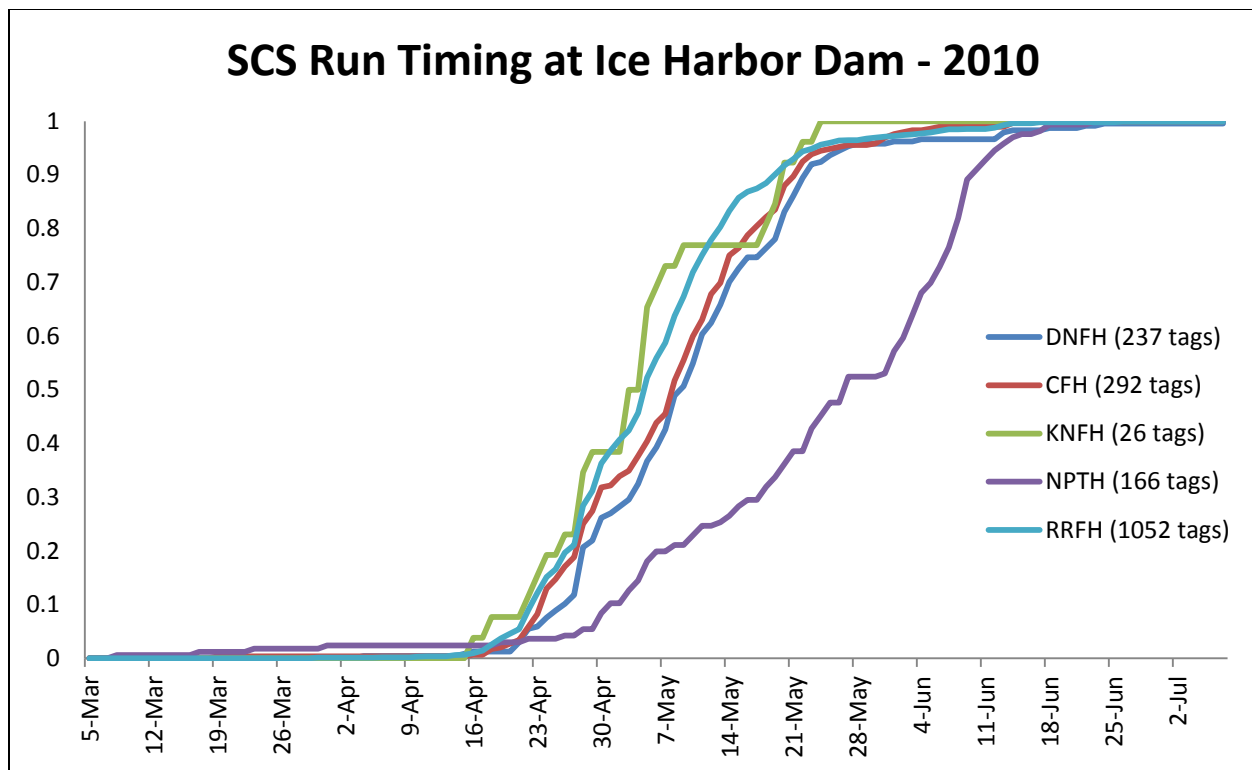


Figure 21. Spring Chinook salmon run timing at Ice Harbor Dam in 2010.

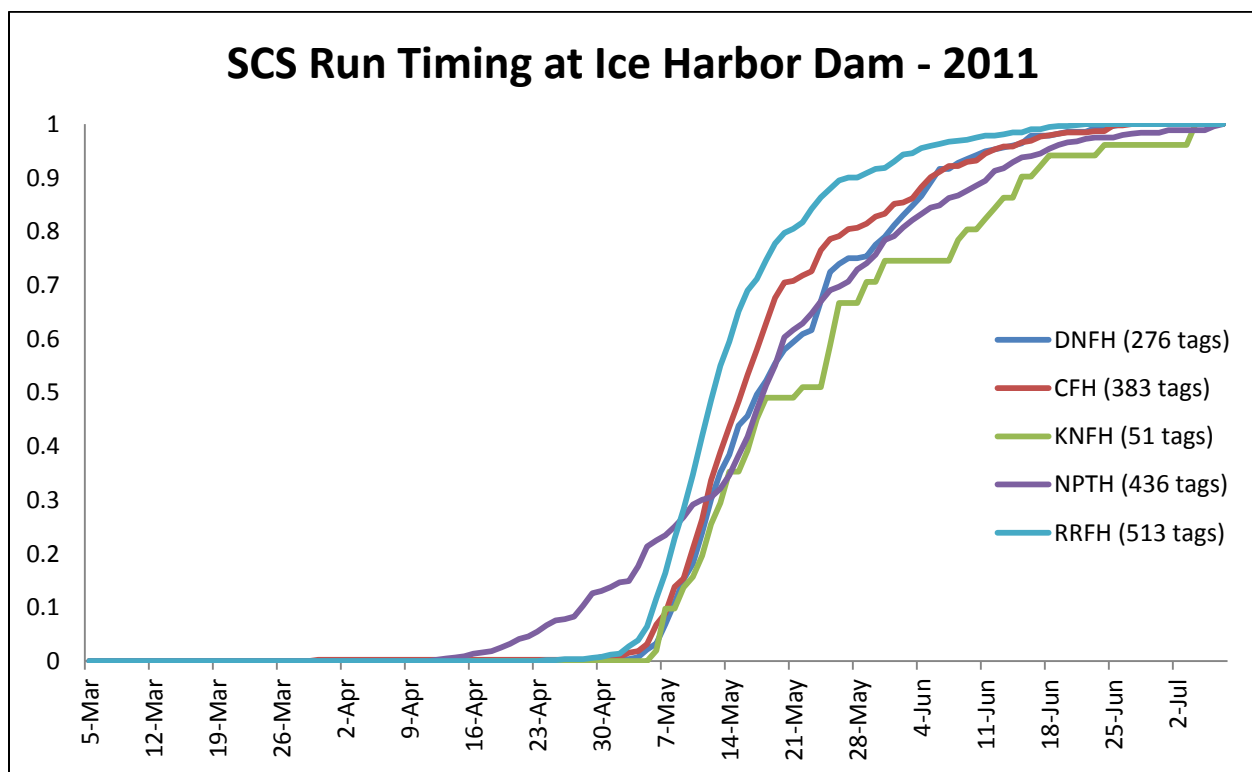


Figure 22. Spring Chinook salmon run timing at Ice Harbor Dam in 2011.

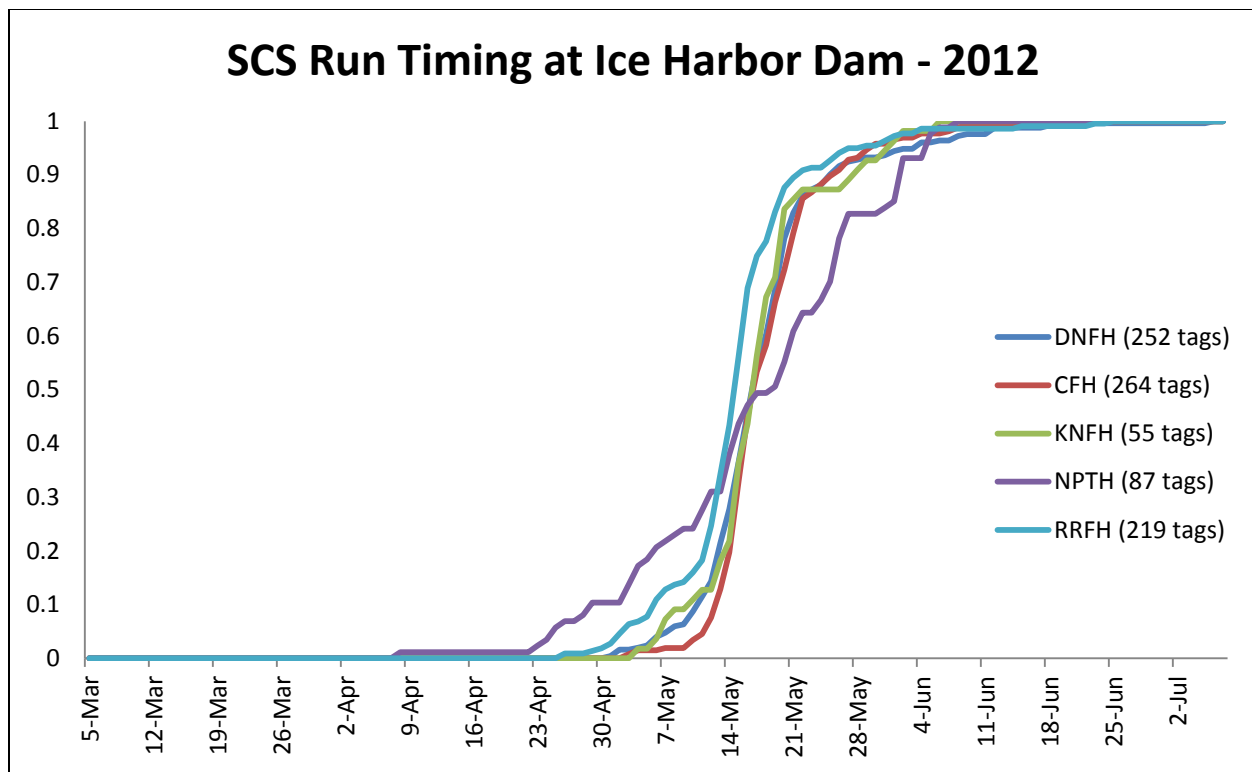


Figure 23. Spring Chinook salmon run timing at Ice Harbor Dam in 2012.

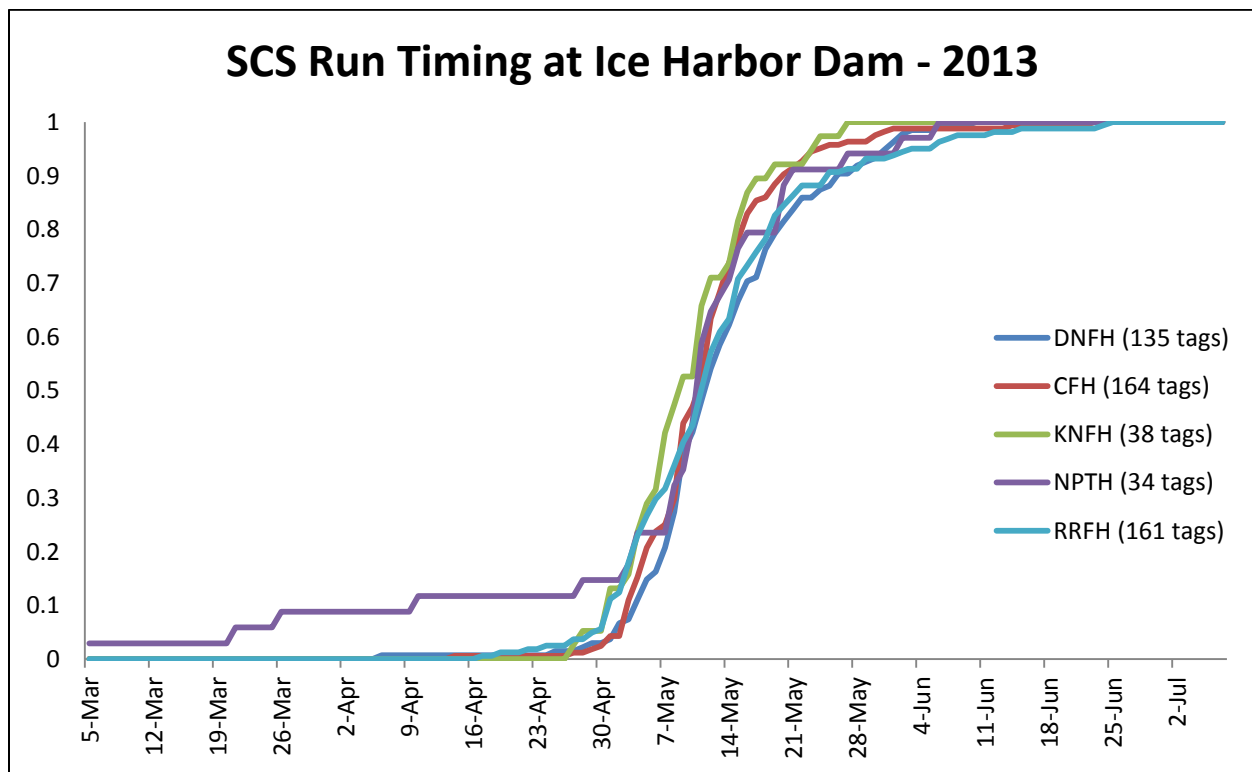


Figure 24. Spring Chinook salmon run timing at Ice Harbor Dam in 2013.

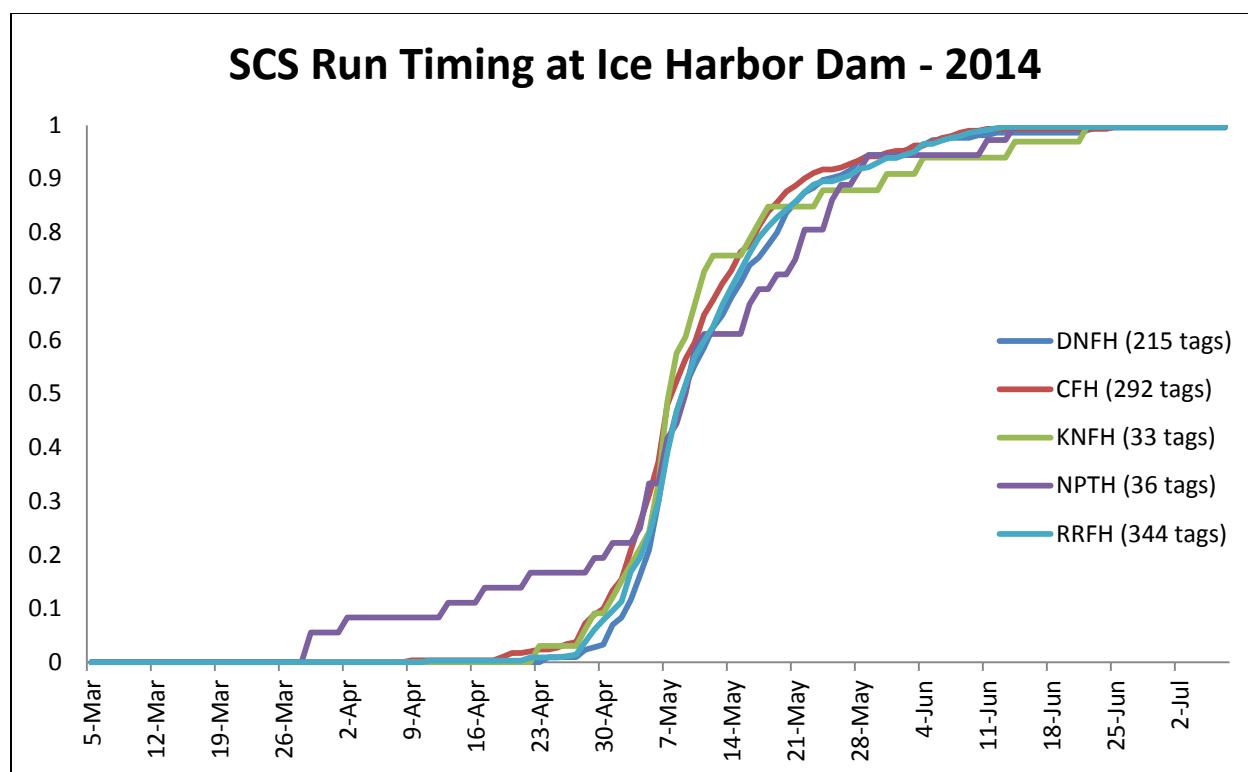


Figure 25. Spring Chinook salmon run timing at Ice Harbor Dam in 2014.

Lower Granite Dam

Table 6 list the median arrival date at Lower Granite Dam for Dworshak NFH spring Chinook salmon and other stocks. The median arrival date at Lower Granite Dam ranges from May 12 to June 3 for all stocks. Other than the unusually late arriving 2010 Nez Perce Tribal hatchery stock, no more than eight days separated the earliest arriving stock from the latest in any given year. There were no statistically significant differences in mean median arrival date at Lower Granite Dam from 2007 to 2014 between any of the five stocks as determined by one-way ANOVA ($F(4,32) = 0.451$, $p = .771$).

Table 6. Median arrival date of spring Chinook salmon at Ice Harbor Dam.

	2007	2008	2009	2010	2011	2012	2013	2014
DNFH	20-May	26-May	20-May	19-May	1-Jun	22-May	17-May	15-May
CFH	23-May	25-May	20-May	15-May	30-May	21-May	15-May	14-May
KNFH			17-May	12-May	3-Jun	21-May	14-May	15-May
NPTH			19-May	11-May	29-May	20-May	15-May	13-May
RRFH	20-May	20-May	21-May	14-May	23-May	19-May	15-May	16-May

Table 7 lists the dates when the first 10% of the total number of PIT tags were detected for Dworshak NFH spring Chinook salmon and for all remaining spring Chinook stocks at Lower Granite Dam for return years 1996 to 2013. Using the 10% arrival date, Dworshak NFH spring Chinook salmon have had similar arrival timing at Lower Granite Dam as the remaining Snake River stocks (**Figure 26**). There were no significant difference in mean 10% arrival date at Lower Granite Dam from 1996 to 2013 between Dworshak NFH stock and all other stocks as determined by a paired T-Test ($p = .828$).

Table 7. Arrival time of Dworshak NFH adult spring Chinook salmon compared to the remaining spring Chinook stocks at Lower Granite Dam based on PIT-tag detections for return years 1996 to 2013.

Return Year	Date of First Detection All other Stocks	Date of First Detection Dworshak Stock	Difference in Days	Date 10% of Tags Detected All other Stocks	Date 10% of Tags Detected Dworshak Stock	Difference in Days
1996	5-May	5-May	0	10-May	14-May	4
1997	3-May	11-May	8	9-May	12-May	3
1998	11-Apr	3-May	22	5-May	4-May	-1
1999	16-Apr	6-May	20	13-May	16-May	3
2000	4-Apr	6-Apr	2	29-Apr	28-Apr	-1
2001	18-Mar	14-Apr	26	20-Apr	22-Apr	2
2002	19-Apr	19-Apr	0	20-May	5-May	-2
2003	7-Apr	10-Apr	3	21-Apr	18-Apr	-2
2004	3-Apr	19-Apr	16	26-Apr	27-Apr	1
2005	23-Apr	30-Apr	7	4-May	7-May	3
2006	1-May	12-May	11	16-May	17-May	1
2007	26-Apr	26-Apr	0	9-May	6-May	-2
2008	22-Apr	27-Apr	5	10-May	10-May	0
2009	28-Apr	6-May	8	14-May	12-May	0
2010	11-Apr	11-Apr	0	30-Apr	3-May	4
2011	1-May	5-May	4	12-May	13-May	1
2012	5-May	5-May	0	17-May	16-May	-1
2013	12-Apr	12-Apr	0	8-May	9-May	1

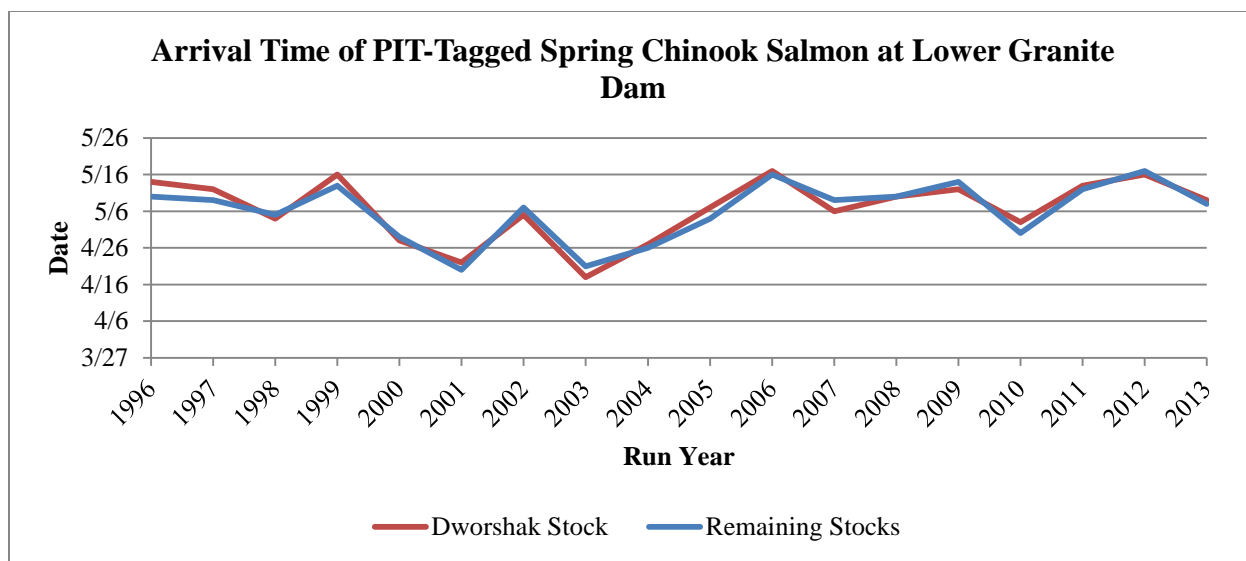


Figure 26. Arrival time (10% Detected) of PIT-tagged spring Chinook salmon from Dworshak NFH and all the remaining spring Chinook stocks at Lower Granite Dam, 1996 to 2013.

Cumulative run timing for all five stocks at Lower Granite Dam are given in **Figures 27 – 34**.

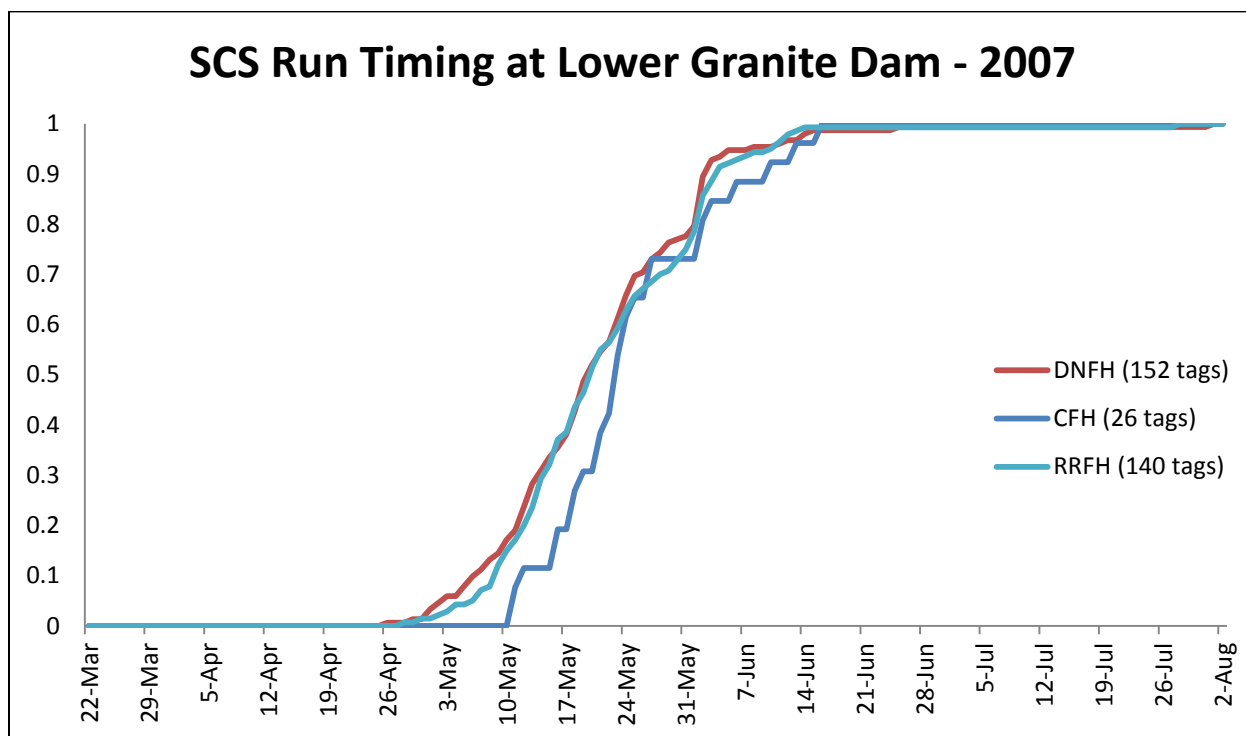


Figure 27. Spring Chinook salmon run timing at Lower Granite Dam in 2007.

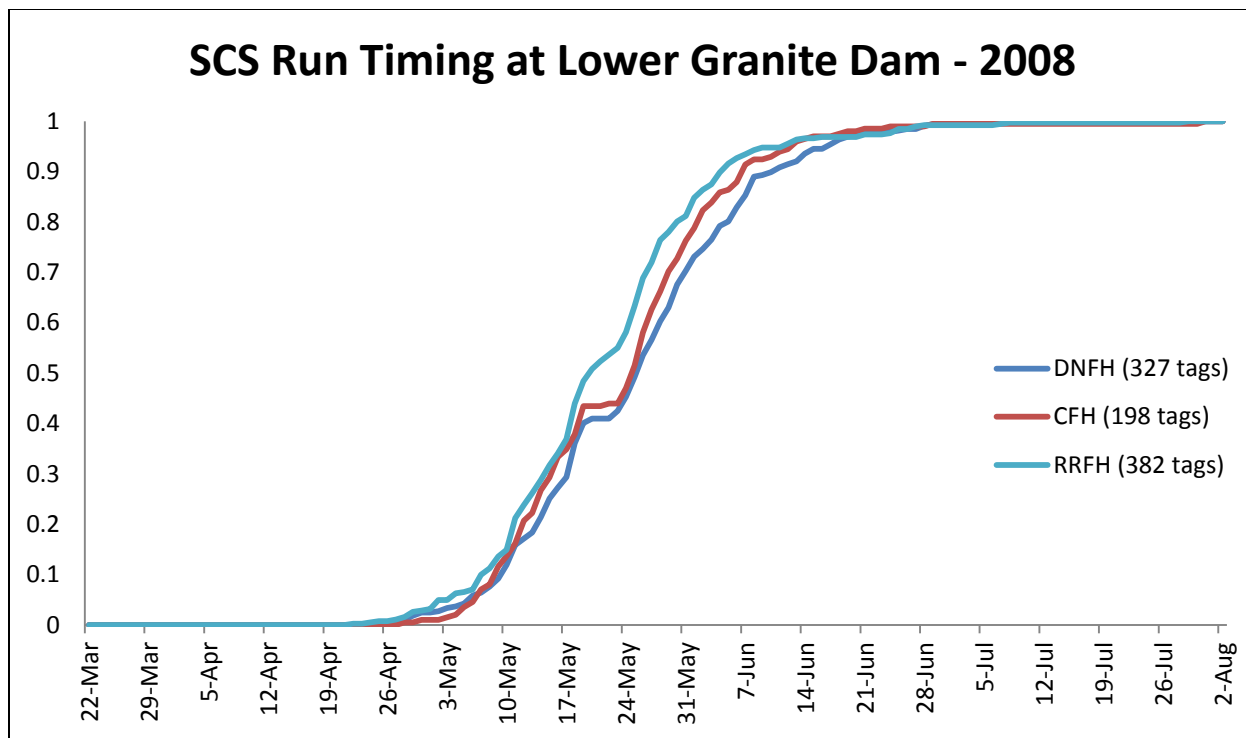


Figure 28. Spring Chinook salmon run timing at Lower Granite Dam in 2008.

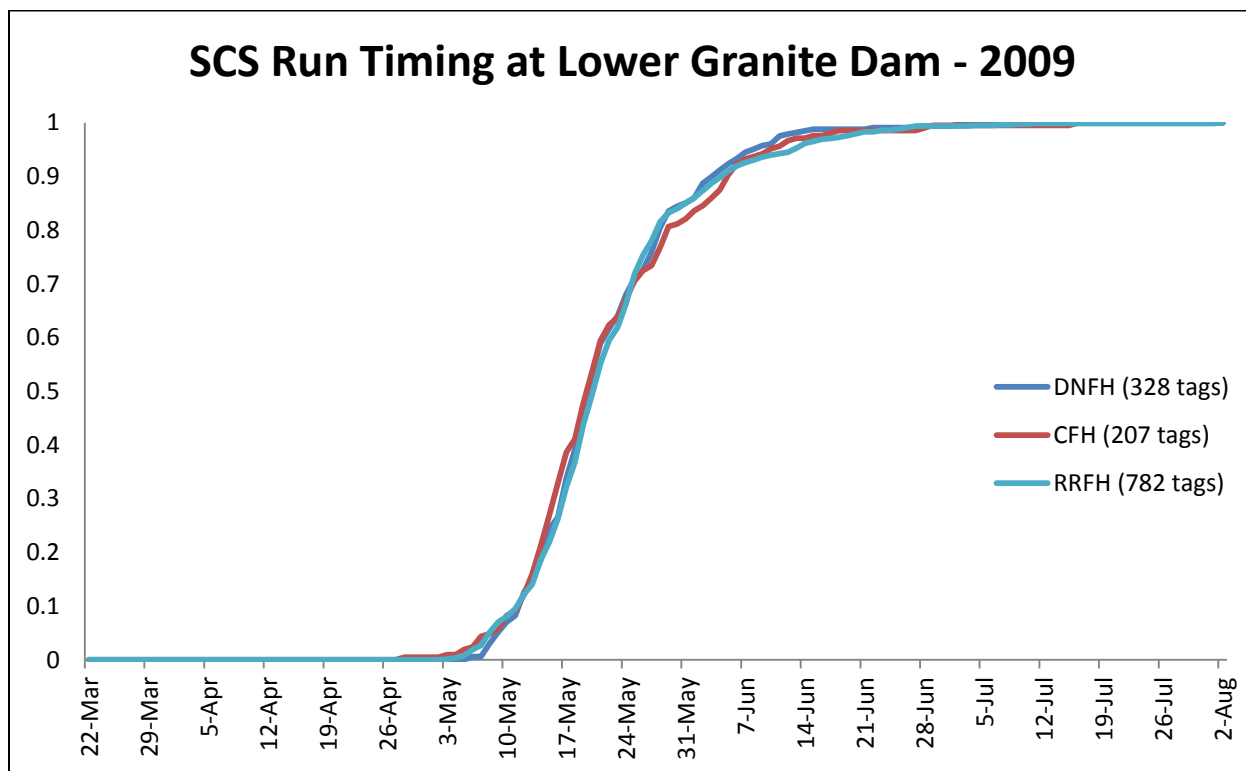


Figure 29. Spring Chinook salmon run timing at Lower Granite Dam in 2009.

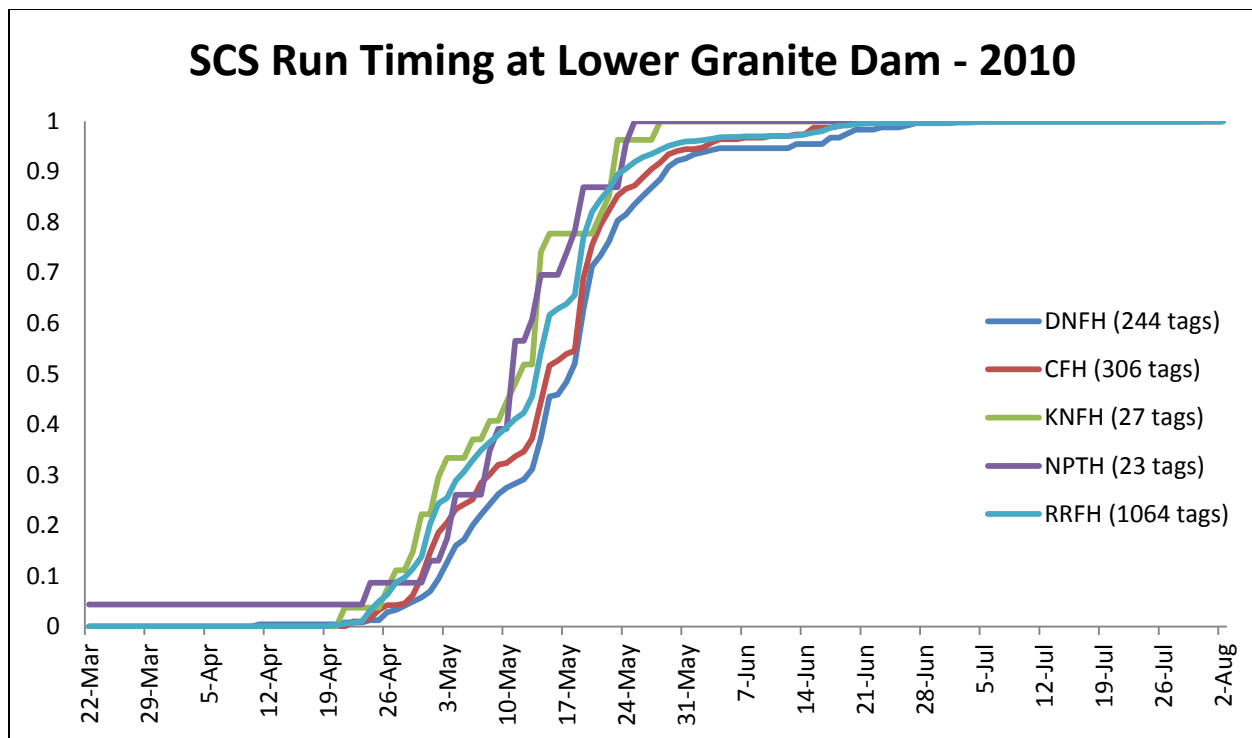


Figure 30. Spring Chinook salmon run timing at Lower Granite Dam in 2010.

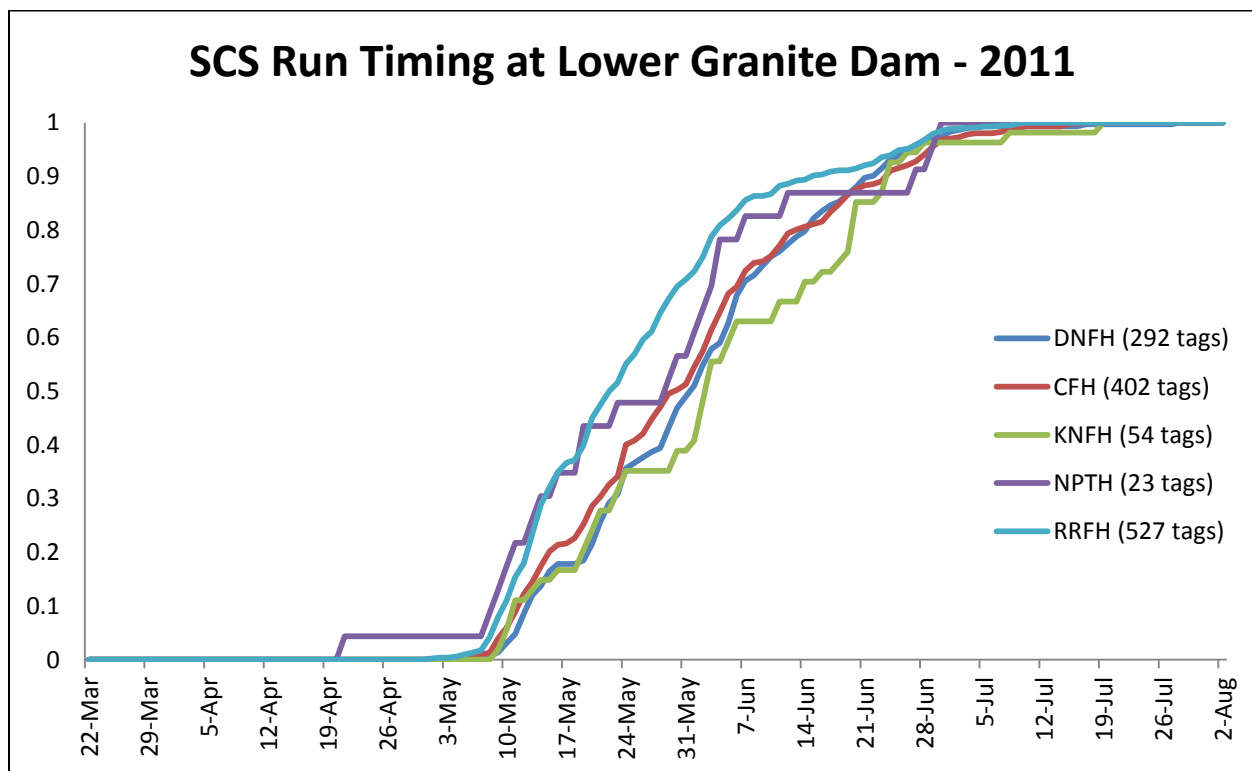


Figure 31. Spring Chinook salmon run timing at Lower Granite Dam in 2011.

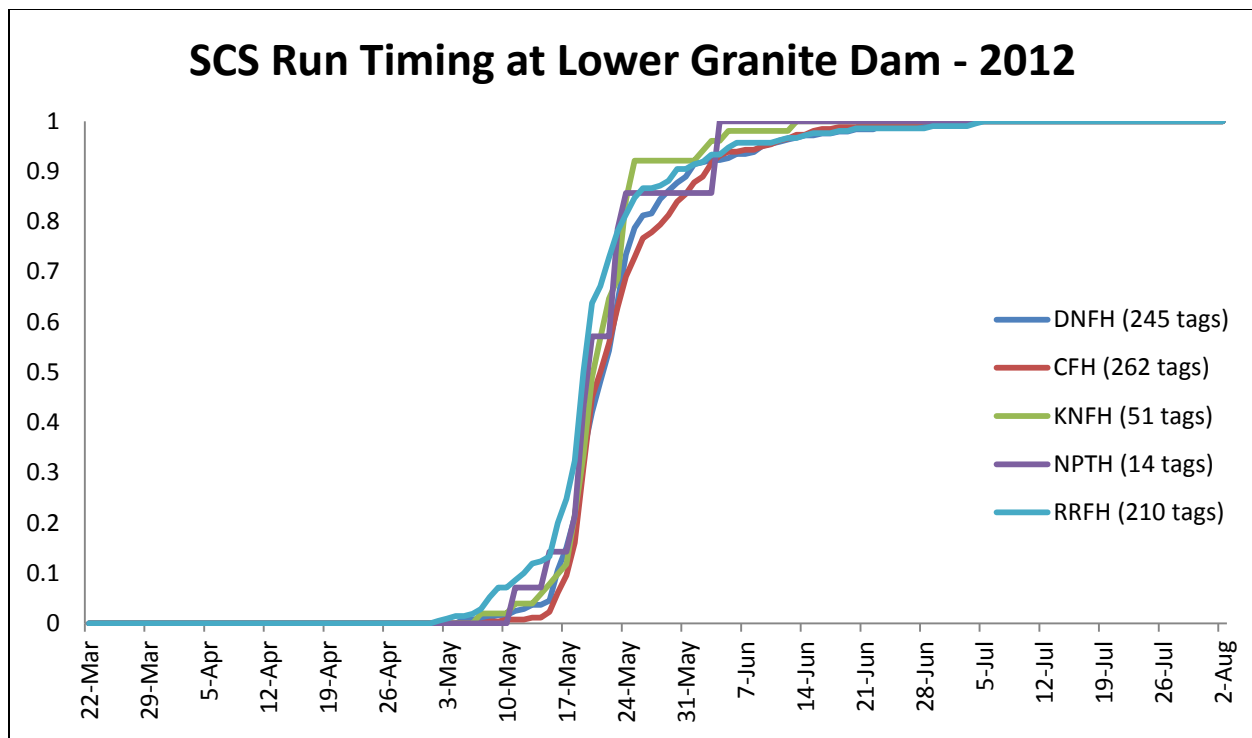


Figure 32. Spring Chinook salmon run timing at Lower Granite Dam in 2012.

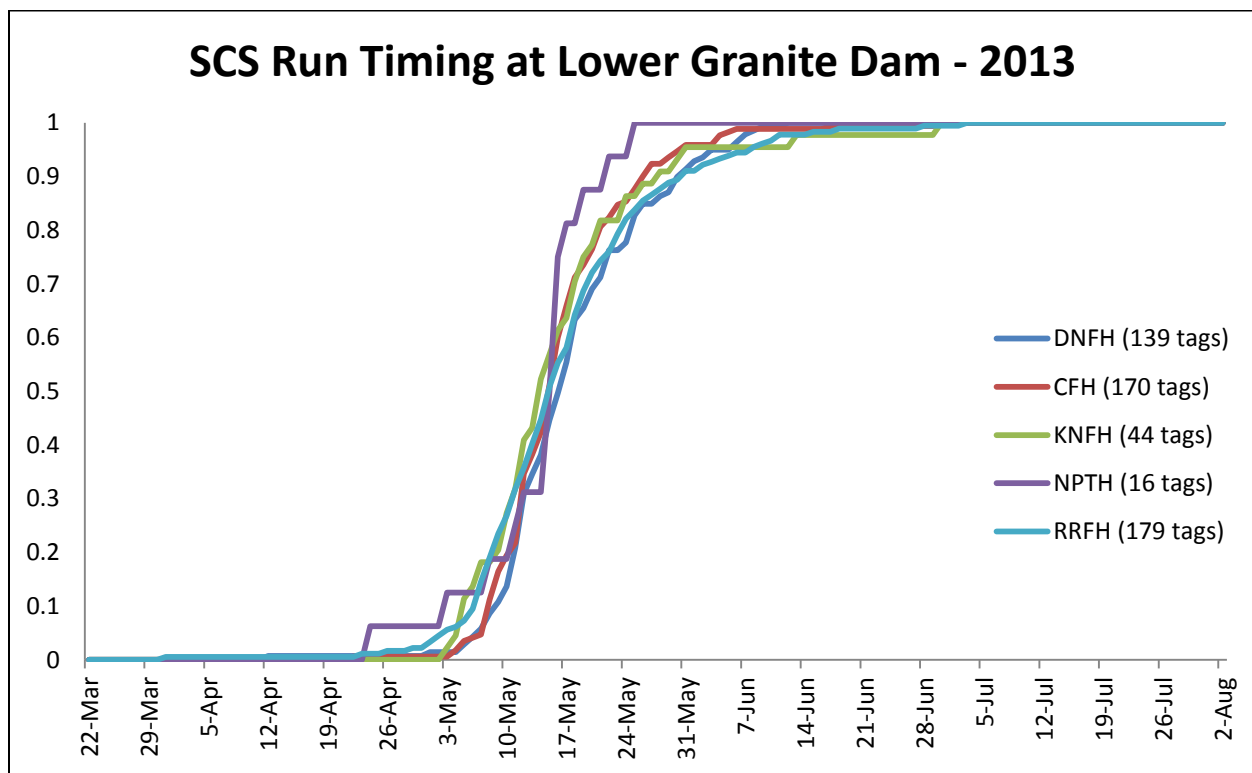


Figure 33. Spring Chinook salmon run timing at Lower Granite Dam in 2013.

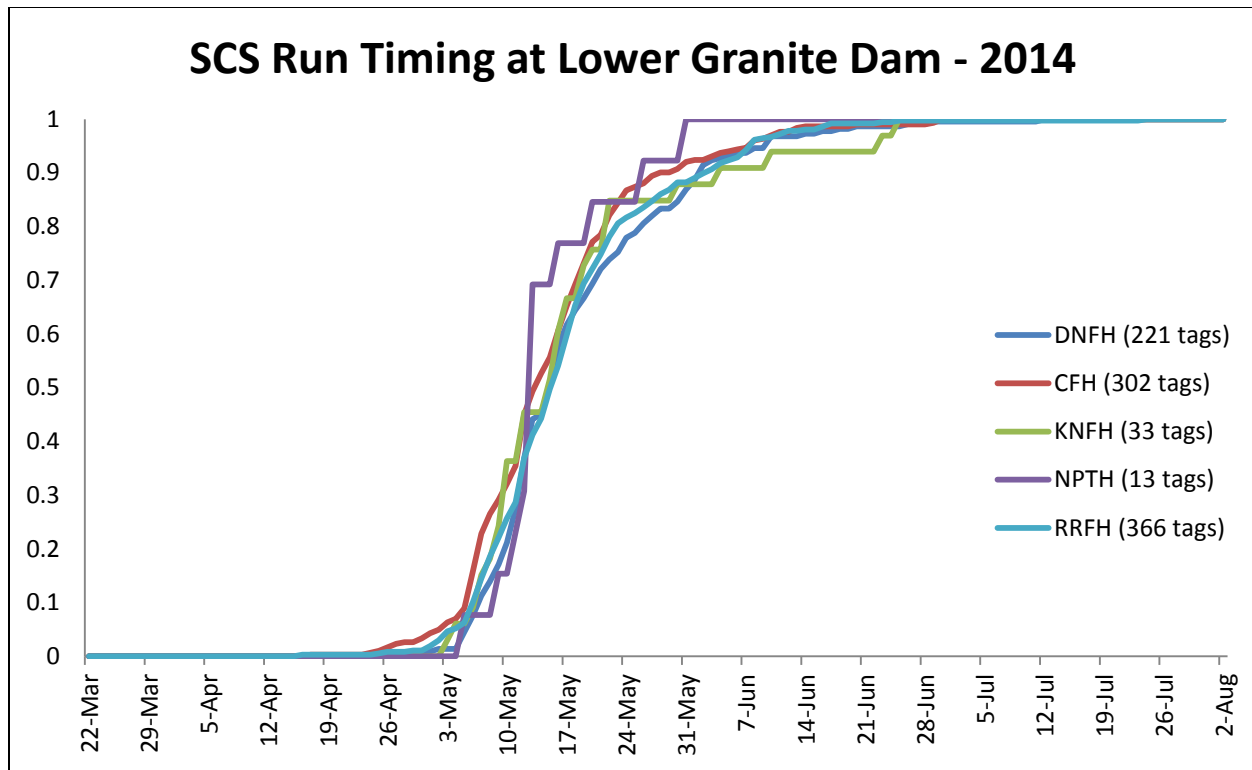


Figure 34. Spring Chinook salmon run timing at Lower Granite Dam in 2014.

Correlation Between Arrival at Lower Granite Dam and Ladder Operation - A correlation was calculated between the date of ladder opening and the date that 10% of the PIT-tagged adults arrived at Lower Granite Dam four years later (**Table 8**). Using the date four years later corresponds to when the 2-Ocean adults would have returned. The correlation coefficient was 0.06441, indicating no influence of the date the ladder was opened on the initial arrival time of the 2-Ocean adults at Lower Granite Dam.

Genetic correlation for spawn dates

Beginning in 2008, Chinook salmon broodstock at Dworshak NFH have been included in a basin-wide assessment for parentage based tracking (PBT) as a means to use genetics to identify hatchery stocks and groups of interest in returning salmon. These data demonstrate only a weak association between the mean spawn dates for 2-Ocean returning adult salmon used as broodstock at Dworshak NFH in 2012 and the spawn dates for their parents in 2008 (**Figure 35**; C. Steele, IDFG, personnel communication). While only a single year of information, these data suggest a significant overlap in progeny spawn dates between early and late spawning adults.

Table 8. Date the ladder at Dworshak NFH was opened and the date when the first 10% of the PIT-tagged adults arrived at Lower Granite Dam four years later.

Ladder Opening		10% PIT-tag Arrival	
1995	19-May	1999	16-May
1996	24-May	2000	28-Apr
1997	19-May	2001	22-Apr
1998	21-May	2002	5-May
1999	4-Jun	2003	18-Apr
2000	15-Jun	2004	27-Apr
2001	12-Jun	2005	7-May
2002	3-Jun	2006	17-May
2003	28-May	2007	6-May
2004	27-May	2008	10-May
2005	18-May	2009	12-May
2006	1-Jun	2010	3-May
2007	5-Jun	2011	13-May
2008	16-Jun	2012	16-May
2009	10-Jun	2013	9-May

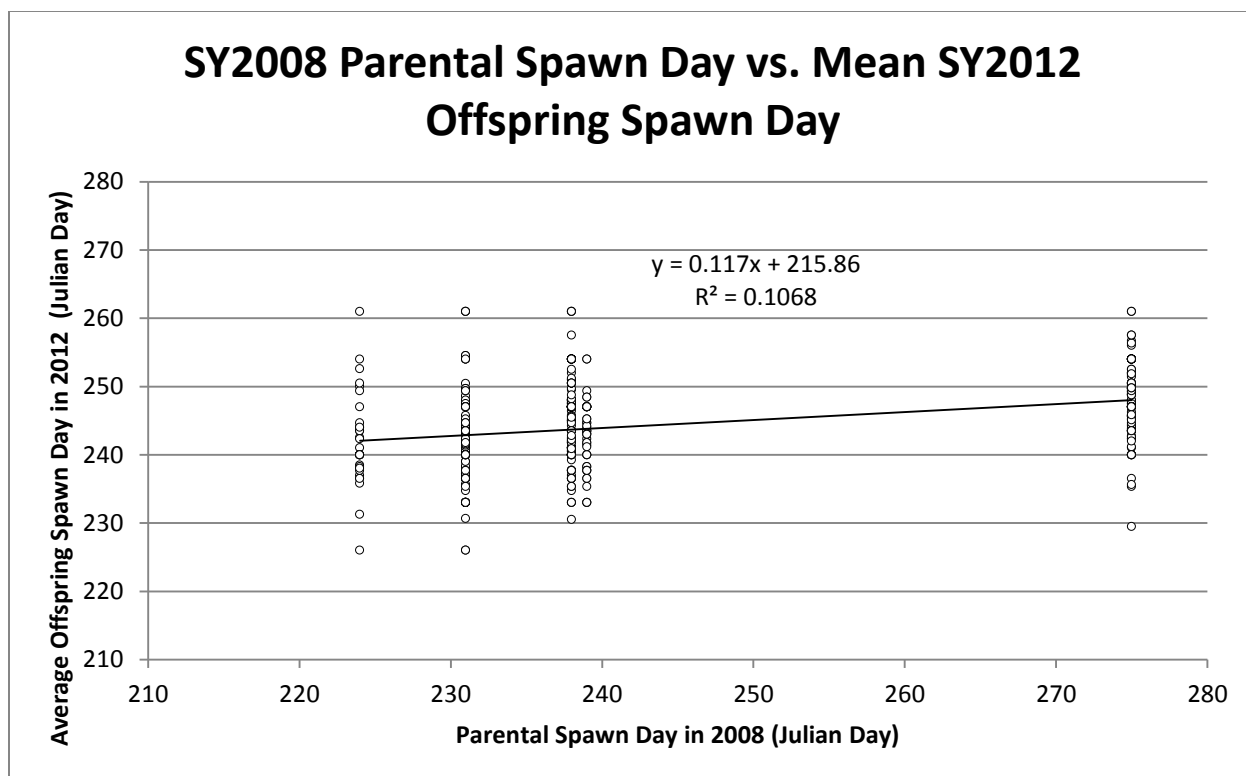


Figure 35. The relationship between parent spawn date for 2008 Dworshak NFH spring Chinook salmon and average spawn date for their progeny in 2012 (2-Ocean retuning adults).

Effects of Brood Stock Collection on Production Efficiency

Holding Mortality

Although adult Chinook salmon begin to arrive in the Clearwater River in late May and early June, they generally do not become sexually mature until mid-August. **Table 9** lists the dates, from 1993 to 2014, that spring Chinook salmon spawning was started at Dworshak NFH. Thus, adults entering the ladder beginning in late May would be held for up to 10 weeks before spawning begins. Pre-spawning mortality has been shown to be higher in those years when the ladder has been opened earlier. **Figure 36** depicts the relationship between pre-spawning mortality rate and the proportion of the rack return inventoried in June. The general trend is for higher pre-spawn mortality when a significant proportion of broodstock is collected early. The implication being that program efficiency is decreased, requiring the collection of additional brood stock to make up those lost to mortality, reducing numbers available for harvest.

Table 9. The relationship between parent spawn date for 2008 Dworshak NFH spring Chinook salmon and average spawn date for their progeny in 2012 (2-Ocean retuning adults).

Year	Date of Ladder Opening	Date of First Spawn
1993	21-May	23-Aug
1994	25-May	23-Aug
1995	19-May	22-Aug
1996	24-May	20-Aug
1997	19-May	26-Aug
1998	21-May	18-Aug
1999	4-Jun	17-Aug
2000	15-Jun	22-Aug
2001	12-Jun	21-Aug
2002	3-Jun	20-Aug
2003	28-May	19-Aug
2004	27-May	17-Aug
2005	18-May	16-Aug
2006	1-Jun	15-Aug
2007	5-Jun	14-Aug
2008	16-Jun	12-Aug
2009	10-Jun	11-Aug
2010	1-Jun	10-Aug
2011	5-Jul	9-Aug
2012	25-Jun	14-Aug
2013	17-Jun	13-Aug
2014	1-Jul	12-Aug

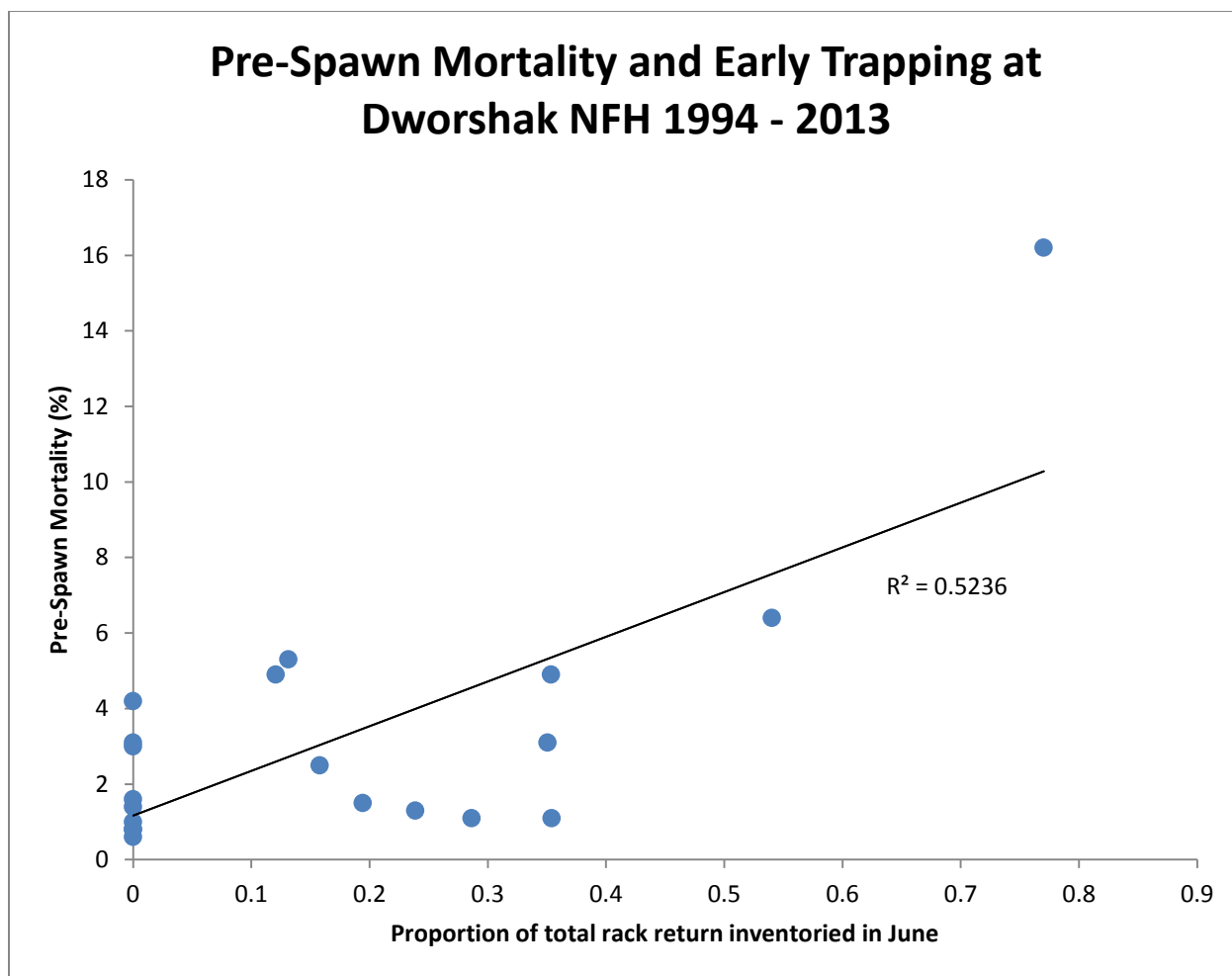


Figure 36. Relationship between pre-spawning rate of mortality and the proportion of the rack return of spring Chinook salmon inventoried in June at Dworshak NFH, 1994 to 2013.

Treatment Cost

Holding spring Chinook salmon requires aggressive treatment with formalin to control for the fungus, *Saprolegnia sp.* Experience from the early years of the program show quite conclusively that unchecked by formalin treatments, the fungus results in significantly higher rates of holding mortality. As brood stock is collected, up to three holding ponds are filled. Treatments of 15 gallons per pond are given three days per week. One barrel of Formalin costs about \$795.00. Average cost of treatment per year is about \$5600.00.

Facility Constraints to Ladders Operation

Dworshak NFH schedules major maintenance tasks during the period from April 15 to July 1 when annual production cycles, and water requirements are at their lowest level. This annual window is used to perform maintenance on the main pump house, intake, main aeration chamber,

and the holding ponds. Since much of this maintenance is performed by contractors, sufficient lead time and work windows are required to adequately plan and perform the necessary work elements. Tighter schedules put the contractors at risk of default and bid prices increase as contractors assume greater risk on these projects.

Main Pump Maintenance

During this period, maintenance is performed on the six main intake pumps. Main pump maintenance includes oil changes, electrical inspections, and pump removal, rebuilding, and reinstallation. Main pump rebuilds must be contracted out well in advance of the outage window through federal acquisition requirements that require a reasonable period of performance (April 15 to July 1).

Holding Pond and Crowder Maintenance

Maintenance for holding ponds and crowdors includes concrete repair, grating repair, valve repair and adjustment, repairs to finger weir, repairs to crowder screens, motors, pulleys, and electrical, and repairs to the pneumatic gate system. The holding ponds are also cleaned during this period. In 2013, all of the pneumatic cylinders required replacement. The replacement cylinders were custom built and required a contract to procure. The entire window of April 15 to July 1 was required purchase the new cylinders and complete repairs.

Main Pump House, Aeration Chamber, and Intake Maintenance

In 2014 and 2015, new degassing towers and main headers were replaced on the main aeration station. Contract period of performance on both contracts was April 15 to July 1. Minimal pumping had to be maintained in order to complete these contracts. In 2012 emergency repairs were performed on one of the rotating screens. This repair required use of contracted dive technicians to complete the repair. Period of performance was April 15 to July 1 during minimal pump usage. Future planned repairs on these structures include replacement of the log boom and intake dredging. Again these repairs will be scheduled during the April 15 to July 1 work window.

References

- U.S. Fish and Wildlife Service 2013. Hatchery and genetic management plan (HGMP).
Dworshak National Fish Hatchery, spring Chinook salmon, Clearwater Subbasin, Idaho.
Dworshak Fishery Complex, U.S. Fish and Wildlife Service, Orofino, Idaho. 86 pp.